CONNECTIONS

DEPARTMENT of ELECTRICAL & COMPUTER ENGINEERING

A. JAMES CLARK SCHOOL *of* ENGINEERING

2020-2021 | Vol. 26 No. 1

CONTENT

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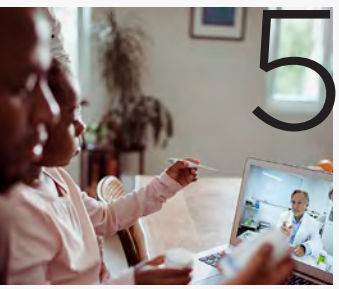

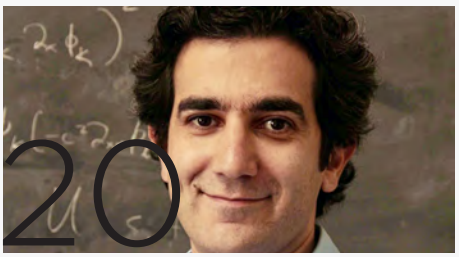

message from the chair

Welcome to the 2020 edition of *Connections*, the annual publication for the Electrical and Computer Engineering Department (ECE) of the A. James Clark School of Engineering. I have been at UMD almost 40 years, and this has been one of the most challenging years yet. During these unprecedented times, we reflect on the strength of our students, faculty, staff, and alumni who have continued their research, teaching, and work throughout the coronavirus pandemic. We have prepared hybrid instruction modes for this Fall based on the guidelines by the University and the State of Maryland. We are also holding all events virtually, to keep our students, staff, and faculty safe and still remain engaged with many opportunities to stay connected. We are doing everything we can to offer a world-class curriculum and an enriching student experience despite these challenging times. Though these times have proven difficult, we have been focused on promoting an inclusive environment and we are excited to welcome students, faculty, and staff from diverse backgrounds for the 2020-2021 academic year. We strive to promote equal opportunities for all.

For this issue of *Connections*, we are pleased to highlight ECE's strides in Embedded Systems and Internet of Things (IoT). With the rapid pace of growth in IoT products and applications, there is a pressing need for engineers with skills in hardware and software design. To address this demand, we have created a Bachelor of Science in Embedded Systems and IoT Degree that is offered at the Universities at Shady Grove. The first cohort of students have begun their rigorous studies this Fall. You will read about ECE Faculty who are involved in this field including our newest faculty member, Sahil Shah, who will begin as an assistant professor in the Spring. Shah's research focuses on the intersection of circuits and systems, neural-engineering and embedded machine learning.

We are proud to offer current and dynamic opportunities for undergraduate and graduate students alike. The Masters of Professional Studies in Machine Learning and the Academy of Machine Learning offer unique and exciting opportunities for students to specialize in, and we have seen great interest and enrollment in both programs.

Since its founding in 2019 by the Clark School, the College of Computer, Mathematical, and Natural Sciences, and the CCDC Army Research Laboratory, The Quantum Technology Center (QTC) has been working diligently to create real-world applications for quantum technology and train the next generation of quantum leaders. This includes applications that can turn into startup companies, solutions within industry, or major advancements for Department of Defense technologies. The center has grown and includes nine fellows and a handful of researchers.

We are also happy to announce that Professor Babis Papamanthou has been named Director of the Maryland Cybersecurity Center, one of the nation's preeminent centers dedicated to cybersecurity research and education. Papamanthou will provide leadership to the unique center that engages computer scientists and engineers with researchers from across campus.

Our ECE faculty members have won many prestigious awards this year and have published numerous articles in a number of highly regarded journals. To name a few: Professors Ray Liu and Min Wu have become members of the National Academy of Inventors; Professor Mohammad Hafezi received the Simons Investigator award and was named a finalist for the second year for the prestigious Blavatnik National Awards for Young Scientists; Professor Cheng Gong received the Young Scientist Award from the Commission on Semiconductors (C8) of the International Union of Pure and Applied Physics; Professor Dinesh Manocha has been named a Distinguished University Professor of the University of Maryland and he has also received the Bézier Award from the Solid Modeling Association; Thomas Murphy was named a Distinguished Scholar-Teacher by UMD. Our strides in research have been published in the journals of *Nature, Physical Review X, Research, and Applied, Nano Letters*, and many more.

We are pursuing major new initiatives to enhance our undergraduate lab facilities, attract more students from underrepresented groups, improve our retention and graduation rates, and offer more fellowships for undergraduate and graduate students. The time, expertise, and financial support of our alumni, whether personal or through industry sponsorship, are crucial to the success of our programs. It is my sincerest hope that you will take the opportunity to help ECE in whatever way is most purposeful to you. To learn more about our department or to discuss any of the subjects outlined in *Connections*, please contact Amanda Stein, Director of External Relations, at steina@umd.edu.

Thank you.

Joseph F. JáJá

PROFESSOR AND INTERIM CHAIR

CONNECTIONS is published once a year 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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ECE Responds to COVID-19

NOVEL COVID-19 PREVENTION ROBOTS

Social distancing measures (maintaining six feet of space between individuals outside of the home) can slow down the COVID-19 outbreak, reduce the chance of infection among high-risk populations, and minimize the strain on the health care system. The need to enforce social distancing is higher in densely populated areas, and some cities are considering the use of drones to monitor pedestrians in large open spaces.

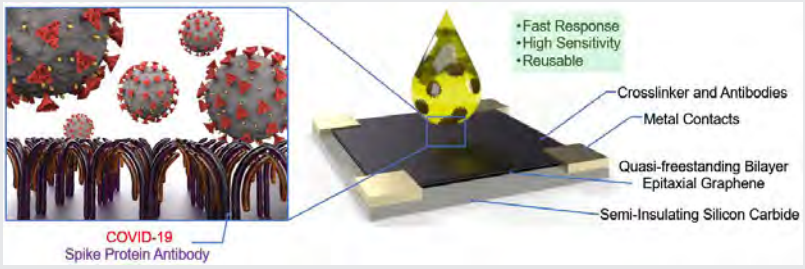
To address the need for social distancing enforcement, GAMMA Group Members of the University of Maryland, led by Professors **Dinesh Manocha** (ECE/CS/UMIACS/ISR/Robotics) and **Aniket Bera** (UMIACS/CS/Robotics), are developing novel COVID-19 Prevention Robots (CPR) using mobile robots and commodity sensors. The NSF EAGER project intends to monitor pedestrian movements, using cameras and other sensors, that will automatically check for vital signs to gather reliable data, and investigate techniques to influence the behaviors of pedestrians to change their social behavior using robots. CPR will automatically monitor pedestrian movements and detect whether they are maintaining social distances. CPR will also combine prior work in social psychology and behavior modeling to develop new methods to influence the behaviors of pedestrians using robots, in terms of social distances.

The development of AI-based technologies for real-time monitoring of individuals across diverse environments can have a significant impact on surveillance, mental health, and human-robot interaction. CPRs could provide more accurate monitoring technologies due to less sensitivity to reactance. This research has the potential to benefit society monitoring systems to detect anomalous individuals in public settings, especially to minimize the spread of COVID-19 cases. ■

EPITAXIAL GRAPHENE-BASED BIOSENSOR PROVIDES RAPID DETECTION OF COVID-19

Assistant Professor **Kevin Daniels** (ECE/IREAP) and his colleagues have developed an epitaxial graphene based biosensor that provides rapid detection of COVID-19.

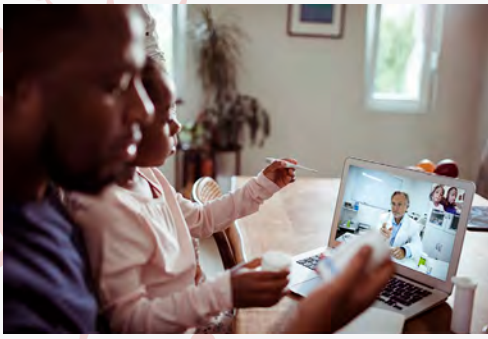
The biosensor, created by Daniels, Dr. **Soaram Kim** of the Institute for Research in Electronics and Applied Physics (IREAP), Dr. **Heeju Ryu** of the Fred Hutchinson Cancer Research Center, Dr. **Seo Hyun Kim** of the University of Georgia, and Dr. **Rachael Myers-Ward** of the U.S. Naval Research Laboratory, tested COVID spike protein ranging from one attogram to one microgram, and can detect COVID spike protein in a few seconds, reuse sensors by simply rinsing them in sodium chloride, and attain results without sending it off to a lab, unlike the current real-time reverse transcription-polymerase chain reaction (RT-PCR) test. Although it is the fastest, most reliable and universally used method for diagnosis, RT-PCR requires a ribonucleic acid (RNA) preparation step, causing a decrease in accuracy as well as sensitivity. In addition, it takes over three hours to complete the current diagnosis for COVID-19.



The researchers use epitaxial graphene, a single to a few layers of carbon atoms with incredibly high surface area, high electronic conductivity, and carrier mobility resulting in ultimate sensitivity for biological sensors. SARS-CoV-2 spike protein antibody and antigen allows high selectivity and an experimental environment that is not dangerous. Therefore, the antibody/graphene heterostructure can synergistically improve sensitivity and provide ultra-fast detection.

"These graphene-based sensors are not only much faster than the RT-PCR test for detecting COVID, but they are orders of magnitude more sensitive with the possibility of detecting the virus sooner post-exposure," said Daniels. "The ability to rapidly detect the virus in individuals, even those who were exposed too recently to be detected by other means, is the goal." ■

WU, MILTON RECEIVE NSF FUNDING TO IMPROVE TELEMEDICINE



Driven by the challenges of the coronavirus pandemic, two University of Maryland faculty have been awarded National Science Foundation (NSF) research funding to improve the capabilities of telemedicine for health professionals and their patients.

Clark School Associate Dean for Graduate Programs and Professor Min Wu (ECE/ISR/UMIACS) is the principal investigator for the NSF Rapid Response Research (RAPID) grant, Understanding and Facilitating Remote Triage and Rehabilitation During Pandemics via Visual Based Patient Physiologic Sensing.

Professor Donald Milton (Applied Environmental Health, School of Public Health) is the co-PI on the $154,550, one-year effort, which includes funding from the Coronavirus Aid, Relief, and Economic Security (CARES) Act. Milton's research on airborne transmission of influenza, and now COVID-19, has received widespread attention.

The University of Maryland School of Medicine/University of Maryland Baltimore (UMB) and North Carolina State University (NCSU) also are participating in the research. The principal investigator at UMB is Simon Ho, a medical school faculty member specializing in cardio-pulmonary rehabilitation. At NCSU, the PI is UMD alumnus Chau-Wai Wong (EE Ph.D. 2017). At Maryland, Dr. Wong was jointly advised by Min Wu and Gang Qu (ECE/ISR).

In this research, Wu and Milton will consider how video-based physiological sensing technologies could be used to facilitate contactless remote triage and rehabilitation during pandemics. Using videos taken by low-cost, consumer-grade cameras, they will devise methods to track, visualize, and archive health indicators such as respiration rate, heart rate, and blood oxygen saturation levels.

The researchers will incorporate these methods into a new contact-free video sensing system, which will be used in a biomedical cohort study being rolled out by a public-health collaboration team. This multimodal data collection will offer insights on the relationship of multiple biosensing modalities, and the data collected will facilitate research on early detection of COVID-19 and related diseases.

During the pandemic, many medical practitioners and their patients have become accustomed to remote telemedicine check-ins, rather than in-person visits. Wu and Milton's video data collection techniques could become part of improved telemedicine systems of the future that would offer enhanced tools for health care professionals to perform remote triage and rehabilitation. Such tools would be valuable not only in future pandemics, but also in routine telemedicine care in rural communities around the world. ■

SPURRING RESEARCH GROUP CREATIVITY

In this time of pandemic, many universities look like ghost towns. Classes are online, dormitories are empty, and so are most experimental research laboratories. The pause button has been pressed on most academic research for the foreseeable future.

But academics are creative, forward-thinking people by nature, and have chosen a life of research and teaching. With the right attitude, the shuttering of in-person experimental research actually could become a crucible in which alternative ideas spark. What could be done to further research ideas in this unusual time of physical distancing?

Professor Reza Ghodssi (ECE/ISR) believes that writing review articles for academic journals is a practice that some faculty/student research groups will find profitable.

"As an alternative to things we cannot do, it is something for us to do now that can spur ideas for the future," said Ghodssi.

Well-written research review papers in academic journals are great resources for academics, students, entrepreneurs, and industry professionals. They provide grounding for new conceptual frameworks, reveal opportunities missed by existing research, and synthesize diverse results.

Because of the multiple layers of value, Ghodssi has made it a practice for his research group to write a review paper for each major project they undertake. To date, the group has produced five review papers: two on the use of the tobacco mosaic virus as a high-surface area nano scaffold; one on the use of chitosan in lab-on-a-chip devices; and in the past few months, papers on ingestible electronic sensing systems and on microsystems for characterizing and sensing bacterial biofilms. ■

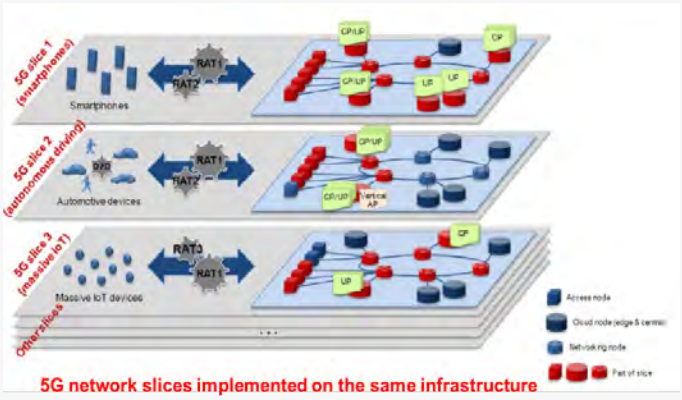
ECE Faculty and Students Expand Research and Programs in Embedded Systems and IoT

In a few years, our human senses to "see, hear, touch, smell and taste" and our ability to rearrange our environment will be supplemented with sensors and actuators that collect information, interact with their environment, and communicate with one another. These devices will be managed by AI algorithms that will analyze voluminous data and provide services and perform appropriate actions in real-time. At the foundation of an "Internet of Things" infrastructure are devices and circuits that perform data acquisition, signal processing, and embedded AI within the devices. These are performed by integrated circuits and microcontrollers that are incorporated within the device, commonly referred to as "embedded systems."

5G Networks and Beyond

Embedded systems have become ubiquitous. They are components of everything we use in our lives and work. The emergence of 5G has made it possible to connect billions of such devices and create what is called a "network immersed world." These technological developments are rapidly changing every aspect of life, work, and society. "They have enabled the implementation of smart cities projects, rapid expansion of telemedicine, efficient monitoring of the environment, smart autonomous cars and ships, smart power grids utilizing renewable sources of energy, and the so-called Industrial Internet, among many other applications and developments," said Professor John Baras, who recently gave a keynote address titled "Smart Cities: Challenges and Opportunities for Better Work-Life-Society," at the ESmartCity Final Conference.

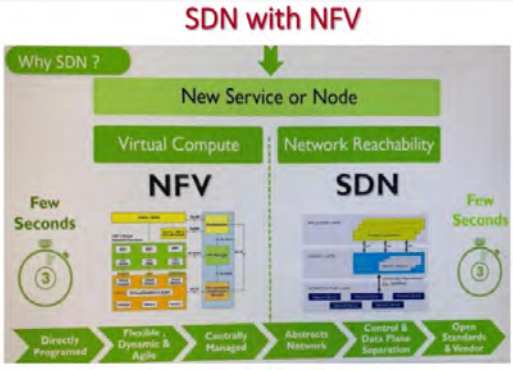
One of the most critical technologies is the intelligent and dynamic management of broadband mobile wireless networks utilizing 5G technologies and beyond. Baras' research group is focused on the investigation of 5G networks and emerging technological systems, employing current and future network management technologies such as Software Defined Networks (SDN) and Network Function Virtualization (NFV). The complementary technologies of SDN and NFV have become more or less standard in terrestrial optical core networks and the "cloud," but their extensions to broadband wireless networks, to hybrid satellite-terrestrial networks, and to drone-enhanced broadband mobile terrestrial networks, pose significant challenges. The research theme of Baras' research group is: "SDN and NFV are key enablers for 5G, IoT and smart networked cyber-physical systems." The group is currently investigating several critical challenges in this general area in collaboration with several companies including Leidos Corp., Nokia Bell Labs, COMCAST, and Booz Allen Hamilton.



5G network slices implemented on the same infrastructure

SRC: NGMN

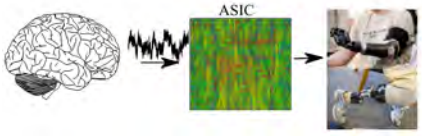
Projects include: establishing and managing dynamic slices to serve particular applications (like autonomous cars, health care, and broadband access in dense areas);massive IoT; disaster relief; alleviating the "digital divide"; satellite back-haul of 5G networks; security and trust of IoT and 5G networks; enabling smart mobility and autonomous cars; networks as a service (NaaS); efficient telehealth services everywhere; massive medical information highways; and social network analytics for integrity-safety-security. The group is also investigating the integration of machine learning (ML) and artificial intelligence (AI) methods for efficient resource allocation in, and network monitoring and management of, such hybrid 5G networks. The group is developing a hybrid hardware-emulation-simulation testbed to test and validate their research results.



Biomedical Applications to IoT and Embedded Systems

"Over the last several decades, embedded systems and IoT devices have transformed consumer electronics," said Assistant Professor **Sahil Shah**. "However, it is only recently that embedded systems and IoT devices have been used for sensing physiological and neurological signals. Continuous monitoring of physiological and vital signals (such as heart rate, blood-oxygen saturation, blood pressure, etc.), with low-power embedded devices, can equip health-care professionals and physicians with tools to make better diagnosis and tailor rehabilitation processes for patients." Innovation in machine learning algorithms and energy-efficient system architectures will also pave a path for the next-generation of invasive and non-invasive devices to help us better understand physiological and neurological activity.

One of the areas of research that Shah's lab pursues, which is critical for developing embedded platforms and low-power IoT devices, is to design integrated circuits and systems for computing in a resource-constrained environment. Implantable devices are an example of an embedded system that has to compute in an extremely low-resource environment. In an ongoing research study, Shah is developing a low-power, application-specific integrated circuit to compute machine learning algorithms (BMI figure). The algorithm predicts kinematics from neural data recorded from a human subject suffering from a spinal cord injury.



Brain-Machine Interface (BMI) figure: An implantable device for recording neural data and decoding kinematics to control prosthetic arms and legs for rehabilitation.

"The eventual goal of such BMI is to enable tetraplegic patients to control prosthetic devices or interact with computers," said Shah. "BMI is a fascinating and interdisciplinary area of research that requires innovation in neurosurgery, neuroscience, algorithms, and embedded/IoT devices."

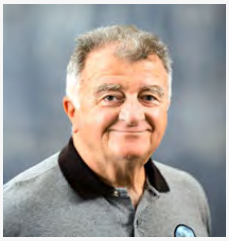
Sahil Shah to Join The ECE Department in Spring 2021

Dr. **Sahil Shah** is currently a Visiting Assistant Professor in the Department of Electrical and Computer Engineering at the University of Maryland, College Park. He will officially join the UMD ECE Department in Spring 2021 as an Assistant Professor. His area of expertise is low-power analog and mixed-signal systems for energy-efficient computation. His lab investigates and designs low-power systems that can compute efficiently in a low-resource environment, such as implantable or wearable platforms. Prior to his arrival at the University of Maryland, Sahil was a postdoctoral associate in the Department of Electrical Engineering at California Institute of Technology. At Caltech, he pursued research on developing robust brain-machine interfaces for enabling patients to control prosthetic devices.

He received his Ph.D. in Electrical Engineering from Georgia Institute of Technology in 2018 where he developed reconfigurable mixed-signal neural networks for monitoring vital and physiological signals. In 2014, he received his M.Sc. from Arizona State University for developing CMOS-based biosensors for monitoring pH in cell-culture media.

Shah's research interests fall into three major areas: Energy-Efficient integrated circuits, Embedded Machine learning, and Bio-Sensing and Monitoring. Sahil's long-term goal is to develop robust and energy-efficient devices that will equip physicians with tools to make better diagnosis, tailor rehabilitation processes for patients, and technology that will help us better understand physiological and neurological activity.

Age of Information



A novel and very important notion in the IoT is the freshness of the information that circulates among the devices that form part of the IoT system, also known as "Age of Information." For the last few years, Professor Anthony Ephremides (ECE/ISR) has been leading research on this aspect of IoT operation and has generated a worldwide following. This new notion, that was first introduced in 2012, has attracted a great deal of interest, resulting in more than 500 papers published on the subject.

There are numerous problems that arise from its study and that are relevant to vehicle-to-vehicle communication and many other emerging applications. Furthermore, it opens up new issues of fundamental research that combine signal processing, information theory, control theory, and may lead to breakthroughs in the near future.

"As part of my sabbatical leave, I am expanding my research collaboration with colleagues in Sweden, France, Greece, Germany, and other countries to develop a virtual international laboratory," said Professor Ephremides.

His work is being supported by three NSF grants and one ONR grant.

Improving Telemedicine with IoT

Professor and University Distinguished Scholar-Teacher Min Wu leads the University of Maryland Media And Security Team (MAST), with main research interests in Information Security and Forensics, Signal Analytics and Data Science, Multimedia Signal Processing and Communications, and Applications of pattern recognitions, learning, and signal processing in biomedicine/healthcare and CPS/IoT.

IoT is enhancing telemedicine, and Wu and Professor Donald Milton (Applied Environmental Health, School of Public Health) are leading research on how video-based physiological sensing technologies could be used to facilitate contactless remote triage and rehabilitation during pandemics. Using videos taken by low-cost, consumer-grade cameras, they will devise methods to track, visualize, and archive health indicators such as respiration rate, heart rate, and blood oxygen saturation levels.

The researchers will incorporate these methods into a new contact-free video sensing system, which will be used in a biomedical cohort study being rolled out by a public-health collaboration team.

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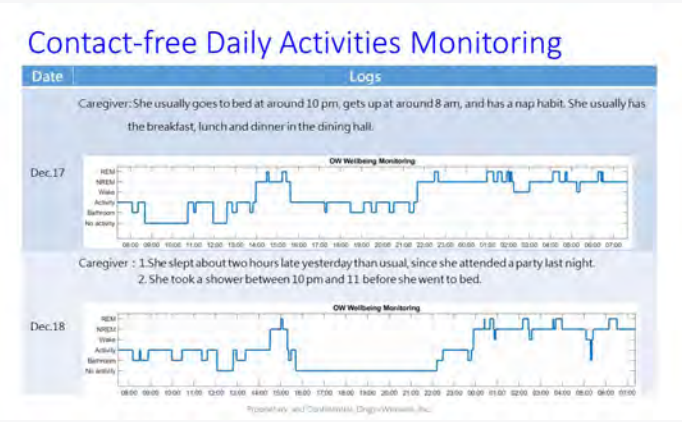
More about their research appears on page 5.

Wireless Sensing and AIoT

After years of fundamental scientific research and ecosystem development, Distinguished University Professor Professor K. J. Ray Liu and his team are the pioneers and industry leaders of the emerging field of wireless sensing and AIoT. The term "wireless" no longer applies only to communication. Now, and to the future, wireless sensing will forever change WiFi, as well as future 5G systems.

Liu's patented wireless AI algorithms leverage the unavoidable but rich multipaths of propagating WiFi signals to achieve unprecedented "scanning" of the indoor environment. His approach significantly improves the resolution of indoor sensing and positioning by leveraging the physical phenomenon of Time Reversal theory, together with advanced signal processing and machine learning. It can detect the tiniest of movements, such as the rise and fall of a human chest in accordance with breathing and heartbeat.

Empowered by key partnerships with the top silicon vendors, his company (Origin) transforms WiFi devices into WiFi sensors. With a simple, patented AI@edge computing software upgrade, partners can offer brand new services to customers.



Proof-of-concept testing at a real elder care apartment.

Students Move Laboratory Experiments Online Using IoT

This summer, under the supervision of Professor **Romel (Mel) Gomez,** a team of ECE undergraduate students developed an Internet of Things framework that allows experiments to be performed remotely.

Using the concept of Digital Twins, the team created a system for remote actuation and sensing of traditional experiments in ECE, housed in the AV Williams Building on campus. The system uses the Azure platform for registration and authentication of users, and connects the front-end user interface with the back-end hardware. Their system includes a real-time video that allows users to see the apparatus as though they are physically in the lab. The team has demonstrated several use cases including a precise positioning system, photovoltaic cell characterization, analog computation using operational amplifiers, and other traditional experiments in analog and digital circuits using internet enabled oscilloscopes, wave generator, power and digital I/O.

A special feature of their system is its capability for "over the air" firmware updates, which allows different programs to be uploaded on the back-end microprocessors via the internet. This greatly expands the flexibility of the system and facilitates customization.

"This is a paradigm shift for labs in the future," said Gomez, who is director of the Bachelor of Science in Embedded Systems and the Internet of Things at the Universities at Shady Grove. "Our restrictions on physically performing labs does not mean that we should forgo the other objectives of labs such as collecting, understanding, and analyzing real world data, and exploring 'what if' scenarios."

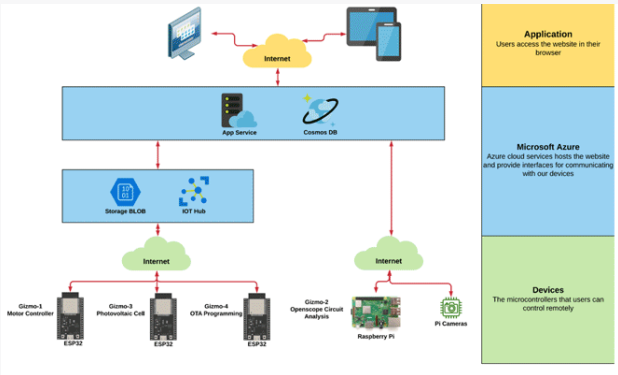
Instead of physically wiring the components on breadboards, remote students make the connections on their User Interface, which is implemented at the back end using transistor switches, relays, and multiplexers. Although the framework may not be applicable to all lab experiments, many labs that utilize electronic signals can be implemented using the framework. Their system lowers the barrier for developing bespoke experiments of the future.

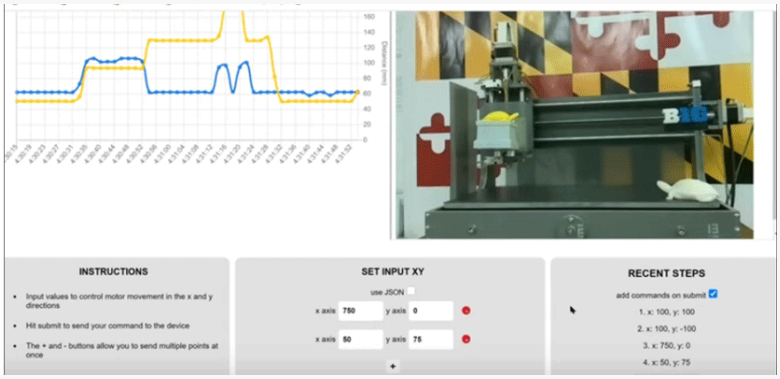
The ECE Department Welcomes First Cohort of Students Into The Embedded Systems & IoT Program

With the rapid pace of growth in Internet of Things products and applications, there is a pressing need for engineers with special skills in hardware and software design. It is critical that these engineers are well-versed with both analog and digital electronics as well as information systems. The new Bachelor of Science in Embedded Systems and Internet of Things (ESIOT) offered at the Universities at Shady Grove was created to address this demand. Situated on the beautiful Universities at Shady Grove campus in Rockville, Maryland, students in the ESIOT program have a unique opportunity to experience small class sizes and individualized attention, while maintaining access to prestigious ECE faculty and resources from the A. James Clark School of Engineering at the University of Maryland, College Park.

The program is among the first of its kind in the country. The overarching goal is to train the workforce in the areas of software, hardware, and applications involving widely deployed smart devices and their interactions with resources in the cloud. Students will learn the elements that go into the IoT from gate-level logic to system-level applications. The program is unique in offering a year-long capstone design project.

Six students with diverse backgrounds are currently registered as the premier cohort. All have an associate degree from community colleges, and several students are supported by one or more scholarships. They are currently enrolled in five rigorous courses taught by faculty from College Park. The courses they are currently taking are: Analog Circuits, Digital circuits, Introduction to C programming, Introduction to the Internet of Things, and Introduction to Discrete Mathematics. The program is intended to be very hands-on, and to maintain this aspiration in the midst of the pandemic, the students are issued individual lab instrumentation and components to allow them to be able to do work remotely. ■





the 2019-2020 graduating class

210 Bachelor of Science Degrees were awarded

43 in the Fall

167 in the Spring

COMPUTER ENGINEERING

83%

employed or attending graduate school
(77% employed, 6% grad school)

$92K

Average Starting Salary

TOP EMPLOYERS FOR CE:

- Northrop Grumman
- Amazon
- Hughes Network Systems
- JHU Applied Physics Lab (APL)
- Booz Allen Hamilton

ELECTRICAL ENGINEERING

80%

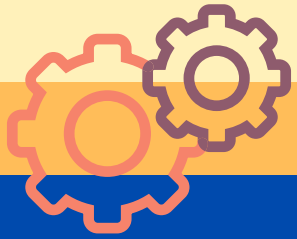
employed or attending graduate school
(69% employed, 11% grad school)

$79K

Average Starting Salary

TOP EMPLOYERS FOR EE:

- NASA
- Northrop Grumman
- NAVAIR
- Lockheed Martin
- Boeing



Course Highlight: ENEE200

Technology and Consequences: Engineering, Ethics, and Humanity

ENEE200 is designed for both engineering and non-engineering students wishing to explore and assess the impact of engineering technology on society and the role of society in generating that technology. Major topics covered in the course include Ethical Theories, Nanotechnology, Data Security, Artificial Intelligence, Design and Cultural Contexts, Equity and Justice in Engineering, and case studies on engineering disasters such as Citicorp, Challenger, Facial Recognition Inequity, and Boeing 737.

"ENEE200 students tell me what they love most about the class is that they have the chance to hear many different perspectives on engineering and technology from each other. This isn't just because we talk about the most interesting topics, because we do. It's also because students learn to pay attention to the way they listen and speak to each other. We tend to think of engineering technology as synonymous with progress. When that happens, the social justice questions are obscured. During ENEE200, after we have established that we all are human with both our own individual experiences and also some common experiences, we are able to ask questions such as progress for whom? That's when the ability to share and listen to each other's life experiences comes in handy. The goal of discussion is not to see how well we can beat up each other's arguments, but to share as many different perspectives as we can before class time is up." —Nicole Mogul, ECE Lecturer

"The ENEE200 Engineering, Ethics, and Humanity Course adds a societal dimension to the concepts we discuss in our technical ECE courses. Through the analytical discussions we had, I have been able to improve my understanding of the varying human considerations that engineers should have when developing solutions to solve problems. The real-world historical case studies we analyzed in class offer an opportunity for students to see what could have been done differently from an ethical, societal, and human standpoint in the field of engineering." —Theodore Gwo, Senior, Computer Engineering

"Professor Mogul is an extraordinary teacher and scientist, and goes the extra mile for her students. She helps identify and build your skills, so you are better able to handle the challenges that may come with the many fascinating topics she chooses for the class. The class was interactive and the TA's were marvelous and all had positive attitudes. The guest speakers gave us new and exciting perspectives." —Alina Boyko, Junior, Electrical Engineering ■

UNDERGRADUATE AWARDS

Eleven students were recognized this past Spring for excellence in academics, leadership and service by the Clark School and ECE Department.

ECE Outstanding Academic Performance Award
Mihailo Rancic

ECE Service Award
Daniel Klawson
Sara Pohland

ECE Chair's Award, Electrical Engineering
Aidan Benderly
Sara Pohland
Edward Salvatierra

ECE Chair's Award, Computer Engineering
David Hsu
Nikhil Uplekar
Timothy Thoresen

Outstanding Engineering Co-op/ Intern Award
Matthew Black

Center for Minorities in Science and Engineering Service Award
Excel Alale

Dean's Kim Borsavage and Pamela J. Stone Student Award
David Boutin ■

Mpact Challenge Projects

Become a Contender: Electric Racecar

As one of the Mpact Challenge projects, Terps Racing had the means to build both a car and a team, allowing many of the students to work full- or part-time on the car last summer under the guidance of Professor **Alireza Khaligh** (ECE/ISR) and two graduate students. The team encompasses almost every engineering discipline in the school and is mostly composed of undergraduates. The vehicle they built has the look and feel of a standard Formula vehicle, with a few notable exceptions: it's significantly quieter and produces no greenhouse emissions, which itself creates a new set of challenges.

To tackle the design of an electric car, they split into teams of 3-5 students, each responsible for taking care of one part of the vehicle, such as sensors, controls, battery, or motors. As the car progressed, they tested it in the parking lot next to the A.V. Williams Building or took it over to Lot 1. By summer's end, they had a working car and a tight-knit club. ■

Revolutionize the Commute: Electric Bicycle

For the past three years, Professor **Romel Gomez (ECE)** has challenged students to push the laws of physics and the limits of technology in his electric bicycle capstone course, where students have developed everything from a solar recumbent bike to an e-mountain bike capable of climbing the stairs of Maryland's Xfinity Center. So when the Mpact Challenge was announced two years ago, he saw it as an opportunity to build on the creativity he was seeing in class through a real-world competition.

The challenge, held October 11-12, 2019, was straightforward and ambitious. Students built electric-powered bikes, no more than 30 kilograms in weight, that can travel 125 miles on a single charge. The bikes traveled for 100 miles on sophisticated indoor trainers able to mimic real-world conditions like elevation, rider weight, and wind shear, with the remaining 25 miles on a designated campus route where riders were required to obey traffic rules, including the 10 stop signs along the course. Seven teams participated, and three claimed 1st, 2nd, and 3rd place. ■

Xin Tian Wins UMD 3MT Competition

The A. James Clark School of Engineering held its annual college-wide Three Minute Thesis (3MT) competition on March 6, 2020.

Electrical and Computer Engineering master's student **Xin Tian**, advised by Professor Min Wu, won for her project titled "Cardio Signal Reconstruction from Finger Tip."

An electrocardiogram (ECG) is a key diagnostic tool for cardiovascular diseases, but it's apparatus is restrictive on user activities. On the other hand, a photoplethysmogram (PPG) can measure the heartbeat-induced pulse in a 24/7 manner through a fingertip attachment. Tian's research applies signal modeling and machine learning techniques to reconstruct diagnostic information normally retrieved from ECG from the more adaptable PPG resulting in better, more accessible preventive healthcare. ■

2019-2020 Distinguished Dissertation Fellows

The fellowships are awarded to outstanding students in the final stages of dissertation work in recognition of their research excellence. Each fellowship recipient will receive $3,000. The following authors' dissertations were selected by a search committee.

Proloy Das
Dissertation: "Bayesian Modeling and Estimation Frameworks for Neuro-Imaging Data Analysis"
Advisor: Professor Behtash Babadi

Ioannis Demertziz
Dissertation: "Searchable Encryption with Bounded Locality"
Advisor: Professor Charalampos Papamanthou

Long Nguyen
Dissertation: "Fluxonium Qubit in the Metastable Regime"
Advisors: Professor Vladimir Manucharyan and Professor Thomas Antonsen

Shenli Zou
Dissertation: "A Gallium Nitride Integrated Onboard Charger"
Advisor: Professor Alireza Khaligh

Chakraborty, Seneviratne, and Zou Named Outstanding Graduate Assistants

ECE graduate assistants Abhishek Chakraborty, Nadee Seneviratne, and Shenli Zou have been awarded the Graduate School's 2019-2020 Outstanding Graduate Assistant Award.

Abhishek Chakraborty is advised by Professor Ankur Srivastava (ECE/ISR). His research interests include high-performance computer architecture, secure hardware designs, logic obfuscation, side channel analysis, and electronic design automation.

Nadee Seneviratne is advised by Professor Carol Espy-Wilson (ECE/ISR). Her research focuses on multiple problems in the domain of speech signal processing such as acoustic-to-articulation speech inversion, speech-based emotion recognition, and depression detection. She is using machine learning models to improve the performance of solutions.

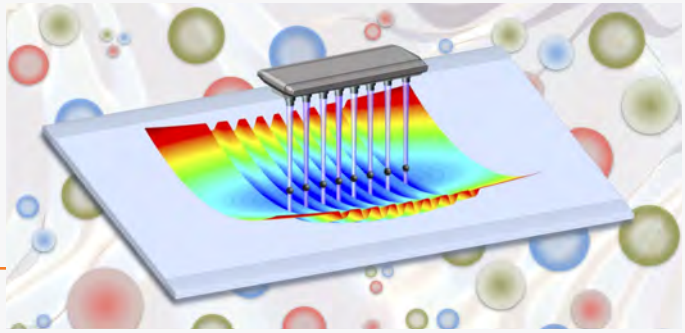
Shenli Zou is advised by Professor Alireza Khaligh (ECE/ISR). His research interests include design, control, modeling and system communication of power electronics converters for plug-in electric vehicle applications, as well as thermal management and magnetics analysis. ■

CHARTING A COURSE TOWARD QUANTUM SIMULATIONS OF NUCLEAR PHYSICS

Computational nuclear physicist **Zohreh Davoudi**, an Assistant Professor of Physics at the University of Maryland (UMD), is collaborating with colleagues at UMD to explore how quantum simulations might aid nuclear physicists. They are working to create some of the first maps between the theories that describe the underpinnings of nuclear physics and the early quantum simulators and quantum computers being put together in labs.

Davoudi and several colleagues, including Electrical and Computer Engineering Professor **Mohammad Hafezi** and Quantum Technology Center Fellow **Chris Monroe**, designed their approach to making maps with an eye toward compatibility with the quantum technologies on the horizon. In a new paper published April 8, 2020 in the journal *Physical Review Research*, they describe their new method and how it creates new simulation opportunities for researchers to explore.

"It is not yet clear exactly where quantum computers will be usefully applied," said Monroe, who is also a Joint Quantum Institute Fellow and co-founder of the quantum computing startup IonQ. "One strategy is to deploy them on problems that are based in quantum physics. There are many approaches in electronic structure and nuclear physics that are so taxing to normal computers that quantum computers may be a way forward." *—Bailey Bedford, JQI* ■



WAKS LEADS NSF QUANTUM PHOTONIC PROCESSORS PROJECT

In a collaboration with researchers from the Massachusetts Institute of Technology, University of Maryland Electrical and Computer Engineering Professor **Edo Waks** (JQI/IREAP/QTC) has been awarded a three-year, $525K National Science Foundation grant as the Principal Investigator to study "Quantum Communication with Loss-Protected Photonic Encoding."

Errors are inevitable in all computing and communication applications, but quantum computers and networks are extremely sensitive to errors and noise which can rapidly accumulate and destroy delicate quantum signals. Quantum error correcting codes are therefore essential for scalable and robust quantum computation and communication. The objective of this program is to create a semiconductor chip that can implement quantum error correcting codes using light. Such chips could open up the possibility for long-distance quantum networks and photonic quantum computers. ■

Researchers Noninvasively Probe an Integrated Circuit

Protecting integrated circuits (ICs) against manufacturing flaws and hardware attacks is a critical challenge for the semiconductor industry.

Quantum Technology Center (QTC) Director **Ronald Walsworth**, QTC Scientist **Matthew Turner**, and MITRE collaborator **Edlyn Levine**, have developed a Quantum Diamond Microscope (QDM), which is a common approach to ensemble Nitrogen-vacancy (NV) wide-field magnetic imaging, augmented with Machine Learning (ML), that provides an optimistic approach for nondestructive physical testing of ICs.

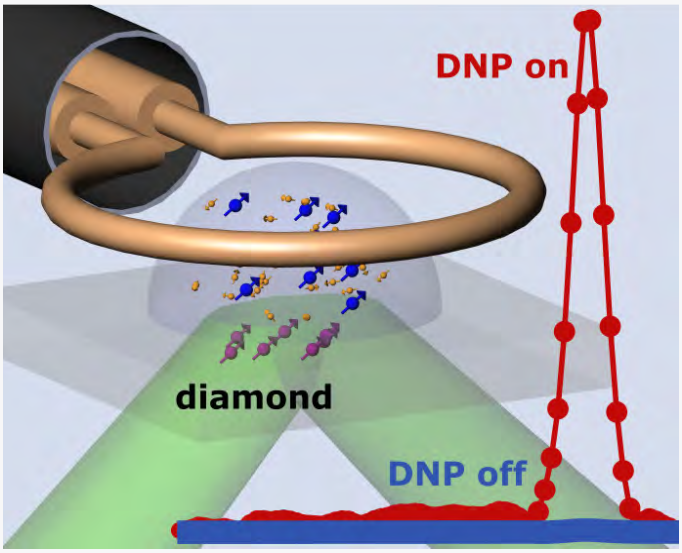
In their paper, published in *Physical Review Applied*, the researchers present a number of advantages of their QDM+ML technique over typical scanning magnetic measurement techniques, which includes the use of wide-field imaging, high spatial resolution, increased frequency range, an increase in image speed of magnetic fields, vector field mapping capabilities, and room temperature operation ability. Of the wide-field NV imaging, Turner, senior author of the paper, said "it is unique, and allows each of these things to perform simultaneously... the approach to focus on naturally occurring DC field mapping is novel."

The researchers supplemented their QDM with ML because it is critical for state classification because of the complex spatial patterns seen in a lot of activity "fingerprints." The machine learning aspect helps identify the patterns of highest variability over their measurements, and classifies the state based on the patterns of variability. ■

Quantum Diamond Sensing

In a study published in *Physical Review X* (PRX), researchers from the University of Maryland's Quantum Technology Center (QTC) and colleagues, report a new quantum sensing technique that allows high-resolution nuclear magnetic resonance (NMR) spectroscopy on small molecules in dilute solution in a 10 picoliter sample volume—roughly equivalent to a single cell.

The experiments reported in the paper, titled "Hyperpolarization-Enhanced NMR Spectroscopy with Femtomole Sensitivity Using Quantum Defects in Diamond," were performed by the research group of Professor **Ronald Walsworth**, QTC Founding Director. Their finding is the next step in previous results, in which Walsworth and collaborators developed a system that utilizes nitrogen-vacancy quantum defects in diamonds to detect the NMR signals produced by picoliter-scale samples. In this past work, the researchers could only observe signals from pure, highly concentrated samples. To overcome this limitation, Walsworth and colleagues combined quantum diamond NMR with a "hyperpolarization" method that boosts the sample's nuclear spin polarization — and hence NMR signal strength — by more than a hundred-fold. The results reported in PRX realize, for the first time, NMR with femtomole molecular sensitivity.



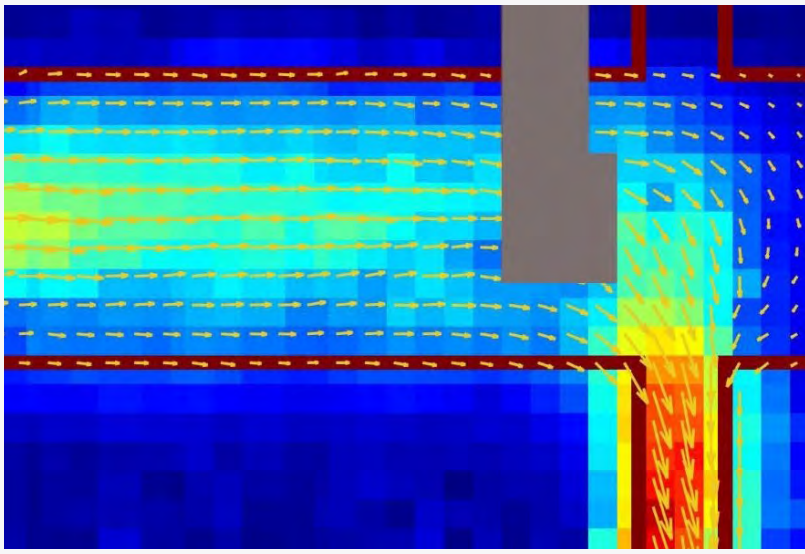
"The real-world goal is to enable chemical analysis and magnetic resonance imaging (MRI) at the level of individual biological cells. Right now, MRI is limited in its resolution, and it can only image volumes containing about a million cells. Seeing individual cells noninvasively with MRI (to help diagnose illness and answer basic questions in biology) is one of the long-term goals of quantum sensing research," said Walsworth, on the impact of the research. ■

Diamonds Shine a Light on Hidden Currents in Graphene

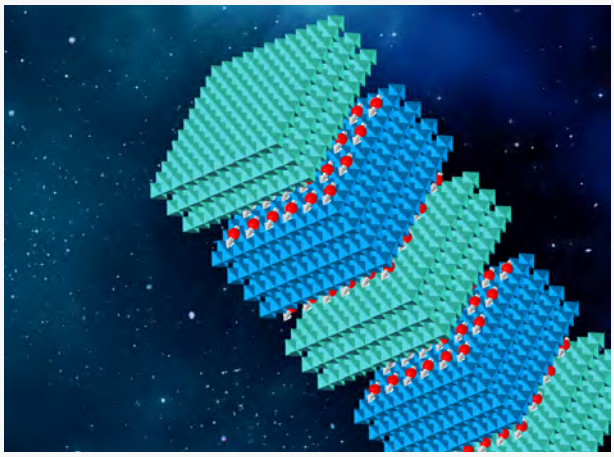
It sounds like pure sorcery: using diamonds to observe invisible power swirling and flowing through carefully crafted channels. But these diamonds are a reality. University of Maryland Electrical and Computer Engineering Professor **Ronald Walsworth**, and Quantum Technology Center (QTC) Postdoctoral Associate **Mark Ku**, along with colleagues from several other institutions, including Professor Amir Yacoby and Postdoctoral Fellow Tony Zhou at Harvard, have developed a way to use diamonds to see the elusive details of electrical currents.

The new technique gives researchers a map of the intricate movement of electricity in the microscopic world. The team demonstrated the potential of the technique by revealing the unusual electrical currents that flow in graphene, a layer of carbon just one atom thick. Graphene has exceptional electrical properties, and the technique could help researchers better understand graphene and other materials and find new uses for them.

In a paper published on July 22, 2020 in the journal *Nature*, the team describes how their diamond-based quantum sensors produce images of currents in graphene. Their results revealed, for the first time, details about how room-temperature graphene can produce electrical currents that flow more like water through pipes than electricity through ordinary wires. *—Bailey Bedford, JQI* ■



Ferroelectric Control of Half-Metallic 2D Electron Gas



A paper by Assistant Professor **Cheng Gong** (ECE/QTC) and his colleagues aims to explore new opportunities for low-power, high-efficiency spintronic devices. "Ferroelectric Switching of Pure Spin Polarization in Two-Dimensional Electron Gas" has recently been published in *Nano Letters.*

Conventional electronic devices leverage the electrons as charge and hence inevitably cause energy dissipation by Joule heating. Using electron spin as the information carrier potentially avoids Joule heating and enables low-energy-consumption spintronic devices. Gong's work aims to create electrons of pure spin and develop viable approaches to efficiently toggle between the binary spin-polarized states (i.e., between spin up and spin down) for logic devices. ■

Quantum Technology Center Gains New Partnerships

In 2019, The University of Maryland announced the launch of the Quantum Technology Center (QTC), which aims to translate quantum physics research into innovative technologies. The center capitalizes on the University's strong research programs and partnerships in quantum science and pursues collaborations with industry and government labs to help take promising quantum advances from the lab to the marketplace. QTC also trains students in the development and application of quantum technologies to produce a workforce educated in quantum-related engineering and applied physics.

The center is a collaboration between UMD's Department of Electrical and Computer Engineering in the A. James Clark School of Engineering, UMD's Department of Physics in the College of Computer, Mathematical, and Natural Sciences (CMNS), and the U.S. Army Combat Capabilities Development Command (CCDC) Army Research Laboratory.

The **CCDC Army Research Lab** is the Army's corporate research laboratory strategically placed under the Army Futures Command. ARL is the Army's sole fundamental research laboratory focused on cutting-edge scientific discovery, technological innovation, and transition of knowledge products that offer incredible potential to improve the Army's chances of surviving and winning any future conflicts.

Dr. Fredrik Fatemi, Branch Chief of Quantum Science at ARL and adjunct professor at UMD, serves as an associate director of QTC.

CONNECT WITH QTC

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Since its founding, QTC has gained other partners including:

Element Six (e6.com) is a global leader in the design, development, and production of synthetic diamond solutions. Element Six focuses on engineering and optimizing the diamond synthesis process to unlock innovative, diamond-enabled applications, including optics, semiconductors, and quantum-enabled sensing.

IonQ is a quantum computing hardware and software company based in College Park, Maryland. IonQ develops general-purpose trapped ion quantum computers and software to generate, optimize, and execute quantum circuits.

TDF Ventures is an early stage venture capital firm that focuses on startups that serve enterprise markets within infrastructure, software, and services.

Leidos, formerly known as Science Applications International Corporation, is an American Defense, Aviation, Information Technology, and Biomedical Research company headquartered in Reston, Virginia, that provides scientific, engineering, systems integration, and technical services.

In September 2020, QTC announced an additional partnership with the **Naval Research Laboratory** (NRL) to identify and pursue opportunities related to quantum technology research. The new partnership with NRL is specifically focused on advancing quantum technology for applications that are relevant to the warfighter, and will involve exchanges of expertise and samples; collaborations in experimental, theoretical, and educational work; mutual research proposals; and the exchange of researchers. QTC is looking forward to adding more partners in 2021. ■

UMD to Lead $1M NSF Project to Develop a Quantum Network to Interconnect Quantum Computers

Quantum technology is expected to be a major technological driver in the 21st century, with significant societal impact in various sectors. A quantum network would revolutionize a broad range of industries including computing, banking, medicine, and data analytics. While the Internet has transformed virtually every aspect of our life by enabling connectivity between a multitude of users across the globe, a quantum internet could have a similar transformational potential for quantum technology.

The National Science Foundation (NSF) has awarded $1 million to a multi-institutional team led by University of Maryland Electrical and Computer Engineering Professor and Quantum Technology Center (QTC) Associate Director **Edo Waks**; Physics Professor and QTC Fellow **Norbert Linke**; Mid-Atlantic Crossroads (MAX) Executive Director **Tripti Sinha**; and co-PI's **Dirk Englund** of the Massachusetts Institute of Technology and **Saikat Guha** of the University of Arizona, to help develop quantum interconnects for ion trap quantum computers, which are currently some of the most scalable quantum computers available.

The group is one of 29 teams who were selected for the Convergence Accelerator program, a new NSF initiative designed to accelerate use-inspired research to address wide-scale societal challenges. The 2020 cohort addresses two transformative research areas of national importance: quantum technology and artificial intelligence.

"We plan to merge state-of-the-art quantum technology with prevailing internet technology to interconnect quantum computers coherently over a quantum internet that coexists with and leverages the vast existing infrastructure that is our current internet," said Waks, Principal Investigator on the project, who also holds appointments in the Joint Quantum Institute and the Institute for Research in Electronics and Applied Physics.

The ability to interconnect many ion trap quantum computers over a quantum internet would be a major technological advance, laying the foundation for applications that are impossible on today's internet.

"The NSF Convergence Accelerator is focusing on delivering tangible solutions that have a nation-wide societal impact and at a faster pace," said Pradeep Fulay, Program Director for the Convergence Accelerator. "Over the next nine months, this team and 10 other teams aligned to the Quantum Technology track, will work to build proof-of-concepts by leveraging the Accelerator's innovation model and curriculum to include multidisciplinary partnerships between academia, industry, and other organizations; as well as team science, human-centered design, and user-discovery. This will ignite a convergence team-building approach."

Their project, part of the NSF Convergence Accelerator's (C-Accel) Quantum Technology Track, will develop the quantum interconnects required to establish kilometer distance quantum channels between remote quantum computing sites. The result will be the MARQI network, a local area network that will interconnect quantum computers at University of Maryland, the Army Research Laboratory, and Mid-Atlantic Crossroads (MAX), with potential for major scalability. In addition, an MARQI Advisory Committee will be created comprising those interested in advancing the project.

"We will leverage a quantum network testbed—of our recently-awarded NSF Engineering Research Center, the 'Center for Quantum Networks' led by University of Arizona in partnership with MIT, Harvard, Yale and several other institutions—for rapid prototyping, benchmarking and scaling up trapped-ion-based quantum routers to be built in the UMD-led Convergence Accelerator program," said Saikat Guha.

Although the quantum internet was an idea previously relegated to research labs, it is now in a position to become an applied technology with transformational potential for society, science, and national security.

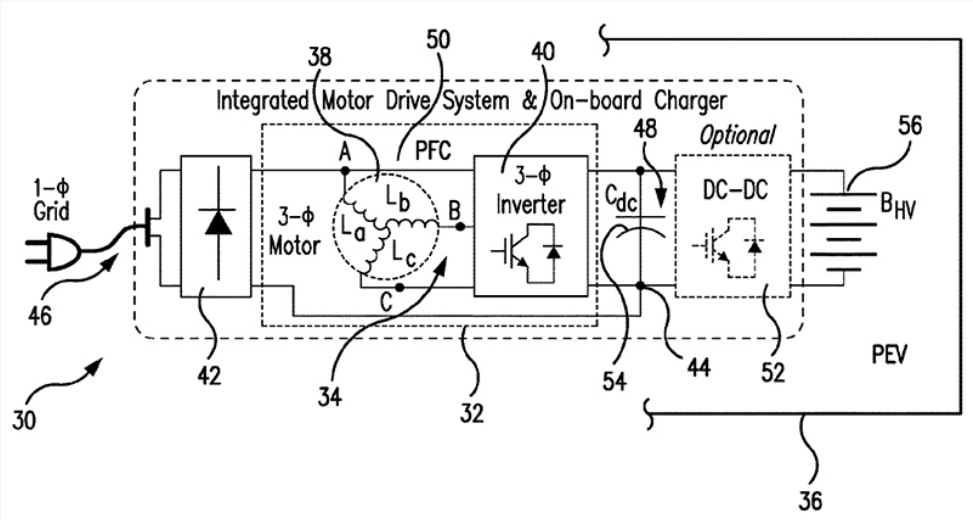
"This Convergence Accelerator program will deliver the future backbone for a fully functional quantum internet that can enable the transmission of quantum data over continental distances," said Waks.

The quantum technology topic complements the NSF's Quantum Leap Big Idea and aligns with the National Science and Technology Council (NSTC) strategy to improve the U.S. industrial base, create jobs, and provide significant progress toward economic and societal needs.

"The quantum technology and AI-driven data and model sharing topics were chosen based on community input and identified federal research and development priorities," said Douglas Maughan, head of the NSF Convergence Accelerator program. "This is the program's second cohort and we are excited for these teams to use convergence research and innovation-centric fundamentals to accelerate solutions that have a positive societal impact." ■

NEW U.S. PATENT: INTEGRATED ONBOARD CHARGERS FOR PLUG-IN VEHICLES

Professor **Alireza Khaligh** (ECE/ISR) and his former students **Yichao Tang** (EE Ph.D. 2015) and **Chuan Shi** (EE Ph.D. 2018) were awarded U.S. Patent 10,562,404 on Feb. 18, 2020 for "Integrated onboard chargers for plug-in vehicles." The invention is an onboard charger for both single-phase (level-1 and level-2, up to 19.2 kW) and three-phase (level-3, above 20 kW) charging of a battery in plug-in electric vehicles (PEVs). The charger is integrated with the propulsion machine-inverter group residing in the PEV, and is controlled to operate in propulsion and battery charging modes. The subject integrated onboard charger provides battery charging at the rated power of the propulsion machine, does not need motor/inverter rearrangement, does not require additional bulk add-on passive components, provides an effective input current ripple cancellation, and operates without rotation of the propulsion machine during the steady state charging. ■

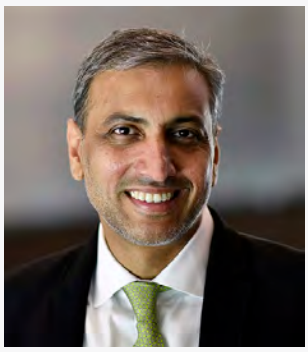


NARAYAN IS PI FOR NSF INFORMATION-THEORETIC SIGNAL PROCESSING SAMPLING RESEARCH GRANT

Professor **Prakash Narayan** (ECE/ISR) is the Principal Investigator for a three-year, $475K National Science Foundation Communication and Information Foundations grant for "Reconstructing Multiple Sources by Spatial Sampling and Compression."

The goal of the project is to understand connections among universal spatial sampling, distribution learning, and compression rate-distortion performance. Furthermore, it aims to create advances in information theory through the introduction of new models and concepts, and in probability distribution learning and machine learning through new formulations and solutions. Expected outcomes are new techniques for joint distribution learning, and a characterization of fundamental performance limits and the structure of optimal universal sampling and compression that will guide algorithm design. ■

SRIVASTAVA WINS NSF FUNDING FOR IC FABRICATION SECURITY



ISR Director **Ankur Srivastava** (ECE/ISR) is the principal investigator for a three-year, $500K National Science Foundation Secure and Trusted Cyberspace award, "A High Level Synthesis Approach to Logic Obfuscation."

Use of untrusted foundries for integrated circuit (IC) fabrication has raised piracy and overproduction concerns. Logic/design locking (also known as logic obfuscation) can secure design details from an untrusted fabrication facility by incorporating a locking key that hides the circuit's functional and structural information.

Dr. Srivastava's project will develop a system-level methodology to design locked digital circuits that are rendered useless if the attacker uses any incorrect key and are resilient to state-of-the art attacks such as a satisfiability attack (SAT). ■

ECE Researchers Represented on Three 2020 MURI Awards

Electrical and computer engineering (ECE) researchers are members of three highly competitive 2020 Multidisciplinary University Research Initiative (MURI) awards. The Department of Defense (DoD) announced it will issue 26 awards totaling $185 million to academic institutions to perform multidisciplinary basic research. The MURI program complements other DoD basic research efforts that support traditional, single-investigator university research grants.

The ECE researchers represented on the 2020 grants are:

Professor **Mohammad Hafezi** (ECE/PHY/IREAP/JQI/QTC) is a member of the team that will investigate "Photonic High Order Topological Insulators." This effort, sponsored by the Office of Naval Research (ONR), is led by Gaurav Bahl at the University of Illinois.

Distinguished University Professor **Tom Antonsen** (PHY/ECE/IREAP) and Professor **Phil Sprangle** (PHY/ECE/IREAP) are members of a team that will investigate "Fundamental Limits of Controllable Waveform Diversity at High Power." This effort, sponsored by the Air Force Office of Scientific Research (AFOSR), is led by Edl Schamiloglu at the University of New Mexico.

College Park Professor **Rama Chellappa** (ECE/UMIACS/CS) and **Tom Goldstein** (CS/UMIACS/ECE) are members of the team that will explore "Mathematical Methods for Deep Learning." This effort, sponsored by the ONR, is led by Richard Baraniuk at Rice University. ■

Clark School Faculty 'AIM-HI' to Address Major Health Challenges

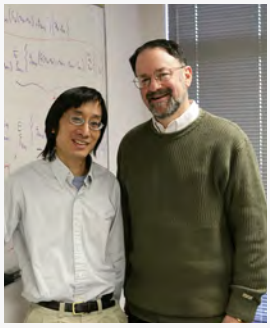
Clark School faculty figure prominently in two of the four joint research projects announced on April 22, 2020 as part of the new AIM-HI (AI + Medicine for High Impact) program to target major health care challenges. AIM-HI brings together experts in medicine and artificial intelligence at the University of Maryland, Baltimore (UMB) and the University of Maryland, College Park (UMCP), and is making available up to $1.8 million in funding over three years.

Carol Espy-Wilson (ECE/ISR) is part of the project, "A Multi-Stage Machine Learning Framework for Prioritization in Mental Health Risk Assessment." This research seeks to lead a shift in thinking about machine learning in mental health by treating the dominant paradigm of individual-level classification or regression not as an end in itself, but rather as providing necessary components in a broader framework, where the central need is to prioritize available resources effectively, given real-world resource constraints.

Other UMCP faculty on this project are Philip Resnik (Linguistics/UMIACS/BBI) and John Dickerson (CS/UMIACS). They are joined by UMB's Deanna L. Kelly of the School of Medicine's Department of Psychiatry and Maryland Psychiatric Research Center.

Pamela Abshire (ECE/ISR), **Reza Ghodssi** (ECE/ISR), and Behtash Babadi (ECE/ISR) are the UMCP researchers involved in "Tackling Chronic Pain: Machine Learning-Enabled Biomarker Discovery and Sensing." This project will search for novel, localized biomarkers associated with gastrointestinal pain through mass spectrometry imaging as well as proteomic, lipidomic and RNA sequence analysis; miniaturized, multiplexed biochemical sensors to measure localized biomarkers; and machine learning. ■

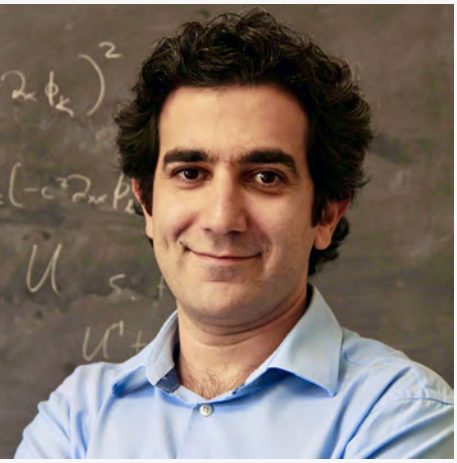
Fu, Marcus Team for New AFOSR Project on Simulation Optimization



Professor **Michael Fu** (BMGT/ISR) is the Principal Investigator and Professor **Steve Marcus** (ECE/ISR) is the co-PI for a new three-year, $871,982 Air Force Office of Scientific Research (AFOSR) project, "Simulation Optimization: New Approaches to Gradient-based Search and Maximum Likelihood Estimation."

Simulation is a commonly used modeling and analysis tool with both military and civilian uses. Simulation optimization aims to guide planning and decision making under uncertainty in complex dynamic settings. It is useful in tasks such as unmanned aerial vehicle path planning, supply chain management, risk management, and various neuroscience applications. This research project will address two overlapping simulation optimization settings.■

Two Major Awards for Mohammad Hafezi



For the second year in a row, Professor **Mohammad Hafezi** has been named a Finalist of the **Blavatnik National Awards for Young Scientists** by the Blavatnik Family Foundation and the New York Academy of Sciences.

Hafezi is among 31 of the nation's rising stars in science who competed for three Blavatnik National Laureate Awards in the categories of Chemistry, Physical Sciences & Engineering, and Life Sciences; he is one of 11 Finalists in Physical Sciences & Engineering. The Blavatnik Awards recognize the past accomplishments and future promise of the most talented faculty-rank scientists and engineers aged 42 years and younger at America's top academic and research institutions.

Inspired by the concept of topology in mathematics, Hafezi is making pioneering contributions in the fields of nanophotonics and quantum optics. His innovative research is tackling a common challenge that has hindered the miniaturization and use of devices that use light-based components for decades: nano-scale fabrication defects that lead to random variations in device performance. Hafezi's topologically-inspired optical devices have proven to be incredibly robust against nano-scale fabrication defects and, together with his theoretical work, have spurred the entirely new field of "topological photonics."

Hafezi has also been named a **2020 Simons Investigator in Physics** by the New York-based Simons Foundation. Simons Investigator Awards in Mathematics, Physics, Astrophysics and Computer Science support outstanding theoretical scientists in their most productive years, when they are establishing creative new research directions, providing leadership to the field, and effectively mentoring junior scientists.

Simons Investigators are appointed for an initial period of five years with the option for renewal for an additional five years, upon the evaluation of scientific impact of the Investigator. An Investigator receives research support of $100,000 per year, and an additional $10,000 per year is provided to the Investigator's department.

Hafezi is known for his contributions in a number of works to synthesize and characterize quantum many-body and topological physics beyond electronic systems. Some of his current interests include efficient characterization and probing of many-body properties in quantum simulators. His research group is currently exploring the application of quantum optics to create, probe, and manipulate correlated electron systems. ■

Murphy Named 2020-2021 Distinguished Scholar-Teacher

Professor **Thomas Murphy** has been selected as a 2020-2021 Distinguished Scholar-Teacher by the University of Maryland. The Distinguished Scholar-Teacher program recognizes a small number of faculty members each year who have demonstrated outstanding scholarly achievement along with equally outstanding accomplishments as teachers. Nominees for the award are selected by their peers; the winners are chosen by a panel of former Distinguished Scholar-Teachers.

Murphy joined the faculty at the University of Maryland in 2002. He is a Professor in the Department of Electrical and Computer Engineering and in the Institute for Research in Electronics & Applied Physics (IREAP). He has been director of IREAP since 2012. Murphy's research interests include terahertz and microwave photonics, two-dimensional optoelectronics, integrated optics, nonlinear and ultrafast optics, electro optics and nonlinear dynamical systems. His research broadly aims to explore new devices and techniques that improve the speed, sensitivity, resolution, and efficiency of optical communication and sensor systems. He is a recipient of a National Science Foundation's Faculty Early Career Development (CAREER) Award and the Defense Advanced Research Projects Agency's Young Faculty Award.

Murphy has been recognized for excellence in both teaching and research at UMD. He received a George Corcoran Award from the ECE Department, and he received the Clark School's Junior Faculty Outstanding Research Award and the E. Robert Kent Outstanding Teaching Award for Junior Faculty. ■

Liu, Wu Named NAI Fellows

Distinguished University Professor **K. J. Ray Liu** and Professor **Min Wu** have been named 2019 Fellows by the National Academy of Inventors (NAI), joining the ranks of some of the nation's most prestigious and creative academic inventors.

The NAI Fellows Program highlights academic inventors who have demonstrated a spirit of innovation in creating or facilitating outstanding inventions that have made a tangible impact on quality of life, economic development, and the welfare of society.

Liu, Christine Kim Eminent Professor of Information Technology, joined the UMD faculty in 1990. He founded Origin Wireless, a start-up company that develops wireless AL analytic technologies for smart home systems. His company invented the world's first centimeter-accuracy indoor positioning/tracking system, and the company's patented Time-Reversal Machine (TRM) Technology has been applied to motion detection, home security, well-being monitoring, human breathing monitoring, and fall-down detection without wearables or cameras. Among many pioneering works, Liu has also revolutionized wireless communication with the concept of cooperative communication.

Wu, who joined the UMD faculty in 2001, holds many awards and recognitions, including a National Science Foundation (NSF) CAREER Award in 2002, an MIT TR100 Young Innovator Award in 2004, an Office of Naval Research Young Investigator award in 2005, a Computer World "40 Under 40" IT Innovator Award in 2007, a 2012 Innovator of the Year award from the Maryland Daily Record, a 2015 University of Maryland Invention of the Year Team Award, and recognition as the IEEE Distinguished Lecturer in 2014.

Liu and Wu join Distinguished University Professor John S. Baras, a 2015 NAI Fellow, totaling three NAI Fellows in the Electrical and Computer Engineering Department. ■

Babadi and Dachman-Soled Receive Promotions

Congratulations to Behtash Babadi (ECE/ISR) and Dana Dachman-Soled (ECE/MC2/UMIACS) on their promotions to the rank of associate professor with tenure.

Behtash Babadi

Babadi joined the Department of Electrical and Computer Engineering in January 2014 after finishing his post-doctoral training at MIT and Massachusetts General Hospital in the areas of Brain and Cognitive Sciences, and Anesthesia. He received his Ph.D. in Engineering Sciences from Harvard in 2011.

An affiliate of the Institute for Systems Research (ISR), Babadi has broad research interests in statistical and adaptive signal processing, neural signal processing, and systems neuroscience. ■

Dana Dachman-Soled

Dachman-Soled joined the Department of Electrical and Computer Engineering and the Maryland Cybersecurity Center (MC2) in the fall of 2013. Prior to joining University of Maryland, she spent two years as a postdoc at Microsoft Research New England. She received her Ph.D. in Computer Science from Columbia University in 2011.

An affiliate of the Institute for Advanced Computer Studies (UMIACS), Prof. Dachman-Soled's research interests are in cryptography, complexity theory, and security. ■

Papamanthou Named Director of MC2

Charalampos (Babis) Papamanthou, an associate professor of electrical and computer engineering, was appointed to a three-year term as director of the Maryland Cybersecurity Center (MC2), effective December 2, 2019.

Papamanthou will provide leadership to the unique center that joins computer scientists and engineers with researchers from across campus in fields such as economics, supply-chain management, and the social sciences.

"My aspiration is to enhance and cement MC2's world-class reputation as a premier cybersecurity research and education institute," said Papamanthou, who has an appointment in the University of Maryland Institute for Advanced Computer Studies (UMIACS).

MC2 was launched in 2010 with strong support from the A. James Clark School of Engineering and the College of Computer, Mathematical, and Natural Sciences (CMNS). Since then, the center has fostered numerous collaborations in cyber-related research, education, and technology development with major corporations that include Cisco Systems, ManTech, Tenable, Lockheed Martin, and Northrop Grumman.

The center also has a robust community of graduate students, with some of them working with UMD faculty on new areas of research like blockchain and cryptocurrency security or post-quantum cryptography.

Papamanthou—working closely with administrators in the Clark School and CMNS—wants to increase research opportunities for students and is also exploring the idea of an MC2 postdoctoral fellowship program. *—Maria Herd, UMIACS* ■

John Baras Named Fellow of AIAA

Distinguished University Professor **John Baras** (ECE/ISR) has been named a Fellow of the American Institute of Aeronautics and Astronautics (AIAA). The citation reads, "For fundamental and high-impact contributions to internet over satellite technology, cybersecurity, automatic control, model-based systems engineering, and for academic leadership."

AIAA confers the distinction of Fellow upon individuals in recognition of their notable and valuable contributions to the arts, sciences, or technology of aeronautics and astronautics. Baras is one of 28 Fellows in AIAA's Class of 2020. ■

Two Awards For Carol Espy-Wilson

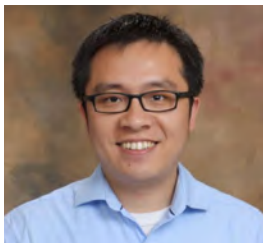
Professor **Carol Espy-Wilson** (ECE/ISR) has been recognized as a Campus Woman of Influence.

Ellin K. Scholnick, the Chair of the President's Commission on Women's Issues, wrote to Dr. Espy-Wilson, "You have served as a pioneer, role model and mentor, especially for African American women in the sciences through your distinguished record of professional accomplishments and advocacy for and mentorship of women in arenas such as the Advancing Faculty Diversity."

The award recognizes women in the campus community who have made exemplary contributions to the improvement of the quality of women's lives, distinguishing themselves by working with and for women on campus and in the community.

Professor Carol Espy-Wilson has also been selected to receive a Faculty-Student Research Award (FSRA) this year from the University of Maryland Graduate School for the academic year 2020-2021. This award will fund research into the automatic detection and monitoring of depression based on the changes in the articulatory coordination of speech gestures. ■

Gong Wins IUPAP Young Scientist Award



Assistant Professor **Cheng Gong** (ECE/IREAP/QTC) has received the 2020 Young Scientist Award from the Commission on Semiconductors (C8) of the International Union of Pure and Applied Physics (IUPAP). He has been recognized for "pioneering the experimental discovery and understanding of novel two-dimensional materials and the highly innovative development of spintronic devices based on such materials."

"It is a great honor to receive this prestigious award. I look forward to making new contributions to the field based on the unique strengths and resources at University of Maryland, and sharing these scientific excitements with physicists worldwide in the upcoming ICPS in Sydney two years later," said Prof. Gong, who joined the University of Maryland faculty in 2019.

The IUPAP Young Scientist Award was established in 2006 to recognize young scholars for their contributions to the field of physics. ■

Chembo Named 2020 Optical Society Fellow

Electrical and Computer Engineering Professor **Yanne K. Chembo** has been elected as a 2020 Fellow of the Optical Society (OSA). Chembo is being honored for "pioneering contributions to the development of microwave photonic systems for aerospace and communication engineering, including monolithic optical frequency comb generators and optoelectronic oscillators."

No more than 10 percent of the total OSA membership may be Fellows at any given time, making each year's honorees a highly selective group. OSA members have served with distinction in the advancement of optics and photonics through distinguished contributions to education, research, engineering, business, and society.

Chembo has been a UMD faculty member since January 2019 and holds a joint appointment in the Institute for Research in Electronics and Applied Physics. His research interests are in the areas of nonlinear, microwave, and quantum photonic systems. ■

Yeung Named Associate Chair for Undergraduate Education

Professor **Donald Yeung** has been named ECE Associate Chair for Undergraduate Education, effective September 1, 2020. Professor Romel (Mel) Gomez will step down from this position after nine years to focus his efforts on the Embedded Systems and IoT program at the Universities of Shady Grove.

In this role, Yeung will be in charge of both the Electrical Engineering and Computer Engineering programs. Yeung has been Director of the Computer Engineering Program, and in that capacity, he led the effort to revise the Computer Engineering undergraduate major to provide greater flexibility to the students. In addition, he created the area of concentration in cybersecurity, helped create the Computer Engineering minor, and he worked with the Computer Engineering faculty to introduce numerous undergraduate and graduate courses into the curriculum. Yeung also contributed significantly to the successful ABET review of ECE's undergraduate programs in 2017. ■

Vishkin Elected to Chair ACM SPAA Steering Committee

Professor **Uzi Vishkin** (ECE/UMIACS) has been elected Steering Committee Chair (SCC) for the Association for Computing Machinery (ACM) Symposium on Parallelism in Algorithms and Architecture (SPAA) for a four-year term. As SCC, Vishkin will be the main point of contact for interactions with related conferences and workshops, the ACM, and related organizations, initiate future SPAA conferences, and lead the SPAA committees for long-term impact awards. ■

Faculty Spotlight: Dinesh Manocha

This year, Professor Manocha has been named a **Distinguished Uninversity Professor** by the University of Maryland, and he has recevied the **Pierre Bézier Award** from the Solid Modeling Association.

Professor **Dinesh Manocha** has been named a 2020 Distinguished University Professor. This is the highest honor bestowed on tenured faculty members at the University of Maryland, and it recognizes not just their excellence in teaching, but also their significant contributions, both domestically and internationally, to their field of expertise and the distinction it has brought the university. This highly selective award is granted to only 7 percent of tenured faculty.

Manocha joined UMD in 2018 as the Paul Chrisman Iribe Professor of Computer Science. He also holds joint appointments in the Department of Electrical and Computer Engineering and the University of Maryland Institute for Advanced Computer Studies (UMIACS). In addition, he is affiliated with the Maryland Robotics Center (MRC) and the Institute for Systems Research (ISR).

Prior to joining UMD, Manocha was the Matthew Mason/ Phi Delta Theta Distinguished Professor of Computer Science at the University of North Carolina at Chapel Hill. He has published 550 conference and journal papers, received 16 best paper or test-of-time awards, and supervised 54 Ph.D. students. Manocha's work is well cited in computer graphics, virtual reality, and robotics literature, with more than 40,000 citations according to Google Scholar. According to the Guide2Research Ranking of Computer Scientists, he currently ranks No. 71 worldwide based on his h-index.

Manocha's research focuses on geometric and scientific algorithms with applications to computer graphics, robotics, and virtual reality. As co-leader of the UMD GAMMA research group, Manocha has developed many widely used software systems related to geometric computing, physically based modeling, virtual reality, and robotics that have successfully transitioned to industry.

Manocha recently developed a new set of real-time robot motion planning algorithms, which are used for autonomous robot action computations. These algorithms are integrated into the widely used robot operating system (ROS) and used with commercial manipulators and mobile robots. His work on multi-agent simulation includes development of new, scalable methods for decentralized navigation of large numbers of agents in real time, and are used in robotics and gaming communities.

Manocha co-founded Impulsonic, a developer of physics-based audio simulation technologies, which was acquired by the Valve Corporation in 2016. Moreover, the audio simulation technologies developed by his group have been licensed by leading commercial vendors and used in game engines and virtual reality systems.

Manocha has been recognized with numerous awards for his impactful research contributions and scholarship. He recently received the 2020 Pierre Bézier Award from the Solid Modeling Association, in recognition of his technically significant and lasting contributions in solid, geometric, and physical modeling and their applications. He was elected to the Association for Computing Machinery (ACM) SIGGRAPH Academy and received the Distinguished Career in Computer Science award by the Washington Academy of Sciences. Other major awards include a National Science Foundation CAREER Award, Office of Naval Research Young Investigator Award, Sloan Research Fellowship, IBM Fellowship, SIGMOD IndySort winner, Honda Research Award, and UNC Hettleman Prize.

He has served as program committee member or program chair of more than 100 leading conferences, and as a member of the editorial board or guest editor of 11 leading journals. He also served as a member of the executive committee of ACM SIGGRAPH. Manocha is a fellow of the ACM, AAAS, AAAI, and IEEE. ■

Babadi Wins Clark School's Junior Faculty Teaching Award

Assistant Professor **Behtash Babadi** (ECE/ISR) is the 2019 recipient of the A. James Clark School of Engineering's Robert E. Kent Teaching Award for Junior Faculty.

The Clark School gives this award to a junior faculty member for excellence in teaching. Babadi is recognized for outstanding teaching evaluations, coursework development in ENEE 101, and senior and graduate level coursework supporting new specialization and graduate programs in machine learning. He was presented with the award at the college's 2019 winter commencement. ■

Edward Ott Elected as Foreign Member of the Academia Europaea

Professor **Edward Ott** has been elected as a foreign member of the Academia Europaea for outstanding achievements and international scholarship as a researcher. He is one of 361 international scholars to be invited to accept membership this year. As a member of the Academia Europaea, his membership section will be Physics and Engineering Science.

Ott is a University of Maryland Distinguished University Professor and a leader in research on theory and applications of nonlinear dynamics.

Founded in 1988, Academia Europaea is the pan-European academy of science, humanities and letters, with membership of eminent scholars, drawn from all countries of Europe, and all disciplines, nationalities, and geographical locations. The Academy fosters the advancement and propagation of excellence in scholarship in the humanities, law, the economic, social, and political sciences, mathematics, medicine, and all branches of natural and technological sciences anywhere in the world for the public benefit and for the advancement of the education of the public of all ages. The aim of the Academy is to promote European research, advise governments and international organisations in scientific matters, and further interdisciplinary and international research. ■

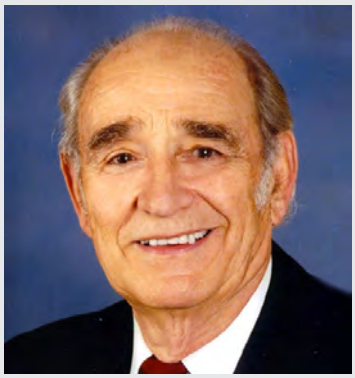
Pamela Abshire Named 2020-2021 ADVANCE Professor

Professor **Pamela Abshire** (ECE/ISR) has been named a 2020-2021 ADVANCE Professor by the University of Maryland. She joins 12 other senior faculty members this year who identify as women within each UMD academic college or school. ADVANCE Professors serve as strategic mentors and knowledge brokers for faculty within their college. They receive training, meet monthly, and help steer all other ADVANCE activities. They provide strategic advice to colleagues on grants and research submissions, workload, work-life policies, developing professional networks, and preparing materials for tenure and promotion.

Abshire's areas of specialty are in the fields of VLSI circuit design and bioengineering. Her research focuses on better understanding the tradeoffs between performance and resources in natural and engineered systems. ■

In Memoriam

Professor Emeritus
Nicholas "Nick" DeClaris



ECE Emeritus Professor **Nicholas (Nick) DeClaris** passed away in Fulton, Maryland, at the age of 89. Professor DeClaris joined the University of Maryland faculty in 1967 and served as Head of the Electrical Engineering Department in the College of Engineering. After stepping down as head, he continued to teach until his retirement in 2011.

DeClaris was born in Drama, Greece, in 1931. As a teenager during World War II, he was a resistance fighter under German and Italian occupation. After the war, he moved to Texas and earned a bachelor's degree and a Jesse Jones Award for Achievement from Texas A&M University.

He went on to earn a master's and doctorate from the Massachusetts Institute of Technology (MIT). After graduating from MIT, he started as an associate professor in Electrical Engineering and Applied Mathematics at Cornell University. He taught in the then new field of Artificial Intelligence and eventually chaired the University's Department of Aeronautics. In 1967, he left Cornell to accept the position of Head of the Electrical Engineering Department at the University of Maryland, a position he held until 1974.

His early work contributed greatly to the disciplines of networks, informatics, and biomedical engineering. Later in his career he divided his time between the College Park campus and the University of Maryland, Baltimore. At UMB, he collaborated closely with Dr. R. Adams Cowley in planning and establishing the Shock Trauma Center at the University of Maryland Medical Center. In his role as Associate Director of Shock Trauma, he standardized medical protocols and procedures for the Maryland Institute for Emergency Medical Services Systems.

During his time as Department Head, he recruited many faculty members who would become leaders in their fields. Nicholas DeClaris is survived by his wife, Clemencia Alvarez, son John-William DeClaris, and brother Michael DeClaris of Greece. ■

Professor Emeritus
Leonard "Len" Taylor

Electrical and Computer Engineering Emeritus Professor **Leonard "Len" Taylor** of Silver Spring, Maryland, passed away on December 9, 2019 at the age of 90.

Taylor was born in Brooklyn, New York, on December 28, 1928. He graduated from Harvard University in 1951 with an A.B. in Physics. He received an M.S. and Ph.D. in Physics from New Mexico State University in 1956 and 1960, respectively.

Taylor was a professor of Electrical Engineering at the University of Maryland from 1967-1996. He then was appointed Professor Emeritus and continued teaching well into his 80s.

Taylor received many awards during his career. He was a Fulbright Scholar and Life Fellow of the Institute of Electrical and Electronics Engineers. Among his achievements was the invention of the microwave scalpel.

He is the author of more than 150 journal articles and conference papers, has had 48 funded research grants, contracts and projects, and holds six U.S. and 16 foreign patents. He has served as a consultant for the U.S. Navy, the National Institutes of Health, the Strategic Defense Initiative Program, and a number of private corporations. Prior to coming to Maryland, he held positions at Case-Western Reserve University, General Electric, White Sands Proving Ground, and Raytheon. He taught at the University of Madrid as a Fulbright Lecturer and at the National Polytechnic University of Mexico under a Ford Foundation program.

Taylor is survived by his wife, Lillian Taylor; daughters Robin Hershey and Allyn Taylor; sons-in-law David Hershey and Larry Kleinberg; and his beloved grandchildren, Josh, Dina, and Sam Hershey, and Lauren Taylor. He was a professor, inventor, avid tennis player, and world traveler who was devoted to his family. ■

Melanie Prange Named Outstanding Director of Graduate Studies

The Graduate School has selected **Melanie Prange** for the 2020 Outstanding Director of Graduate Studies Award. Melanie has served as Director of Graduate Academic and Student Affairs for the Electrical and Computer Engineering (ECE) Department since 2011.

Directors of Graduate Studies (DGSs) play a critical role in shaping the direction of graduate education and in enabling and ensuring the academic success of graduate students.

As Director, Melanie Prange assists, guides, and enables ECE graduate students and faculty by providing excellent customer service, leading by example, and communicating resources effectively.

"I want to take this opportunity to express my appreciation for Melanie's utmost professionalism in handling all matters related to our graduate programs and the thoughtful way she deals with our graduate students," said Professor and ECE Department Chair, Joseph JaJa.

"Melanie manages all aspects of our graduate studies office ranging from admissions, to welcoming/orientation of incoming students, to supporting existing students through qualifying requirements, proposals, and thesis defenses, to appointment, orientation, and training of our TA's," said ECE Professor and Associate Chair for Graduate Studies, Sennur Ulukus. "An enormous amount of work flows through Melanie's office, and she handles it with efficiency and professionalism. I am grateful to Melanie's many contributions to our graduate students and to the department."

Prior to joining the Department of Electrical and Computer Engineering, Melanie received a B.A. from Rutgers University and subsequently an M.A. from UMD.■

ECE Student & Staff Awards

Irwin and Walker Win ECE Staff Service Award

Emily Irwin and Edna Walker have received ECE's 2020 Corcoran Staff Service Award. The award is given in recognition of their dedication, excellence in performance, and commitment to service to the department this year. ■

Narayan Wins ECE Graduate Teaching Assistant Award

Amith Narayan 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. ■

D'Antonio Wins ECE Graduate Student Service Award

Michael D'Antonio 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. ■

Khaligh Wins ECE Jimmy H.C. Lin Innovation Award

Jimmy H. C. Lin Award for Innovation has been awarded to Professor **Alireza Khaligh**, and his former students, Yichao Tang (EE Ph.D. 2015), and Chuan Shi (EE Ph.D. 2018) for their patent "Integrated Onboard Chargers for Plug-in Vehicles." Yichao Tang is a systems engineer at Texas Instruments, Santa Clara CA, and Chuan Shi, a power electronics engineer at Seres (formerly called SF Motors), Santa Clara CA.

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. ■

Dennis Andrucyk Named Director of NASA Goddard Space Flight Center

PHOTO: NASA

Dennis Andrucyk ('82, electrical engineering) has been named director of NASA's Goddard Space Flight Center.

Andrucyk, who has been with NASA for the past 31 years, has held a number of positions at the space agency, including 26 years at Goddard. Prior to becoming Goddard's acting director, Andrucyk served as NASA's acting chief technologist and as deputy associate administrator for NASA's Science Mission Directorate (SMD) at the agency's headquarters in Washington. In this role, he created innovative, inclusive, and diverse teams in pursuit of the nation's science goals in astrophysics, heliophysics, Earth science, and planetary exploration. Before that, he served in a number of capacities at Goddard, primarily in the engineering organization, and was Director of Engineering from 2010-2015.

Andrucyk has served on several national and international space partnership teams including the U.S.-based Space Technology Alliance as one of three voting members on the North Atlantic Treaty Organization's (NATO) Sensors & Electronics Technology (SET) panel.

Before joining NASA in 1988, Dennis served at the Department of Defense as both a contractor and a civil servant. He has worked at the National Security Agency, the Naval Research Laboratory, Westinghouse Electric, Northrop Grumman, and General Electric.

Andrucyk received his B.S. in electrical engineering in 1982 from the University of Maryland, College Park. Of his awards, he has twice been the recipient of the NASA Senior Executive Service Meritorious Presidential Rank Award, the NASA Medal for Outstanding Leadership, the NASA Exceptional Service Award, the Goddard Outstanding Leadership Honor Award, and the Goddard Exceptional Achievement Award in Diversity and Equal Employment Opportunity. ■

Rose Faghih Named an MIT Technology Review 2020 Innovator Under 35

PHOTO :Jeff Lautenberger, Cullen College of Engineering, University of Houston.

Rose Faghih ('08, electrical engineering), has been named to MIT's prestigious annual list of Innovators Under 35 in the Visionary category. Every year, the world-renowned media company has recognized a list of exceptionally talented technologists whose work has great potential to transform the world.

Faghih, an assistant professor in the Department of Electrical and Computer Engineering at the University of Houston, has been recognized for her project on sensor-laden wristwatch that monitors brain states, that could determine what's happening deep inside your brain. Faghih completed her postdoctoral training at the Department of Brain and Cognitive Sciences and Picower Institute for Learning and Memory at MIT. She received her M.S. and Ph.D. degrees in Electrical Engineering from MIT and graduated summa cum laude and first in her class from the University of Maryland with a bachelor of science in Electrical Engineering (Honors Program Citation). Her other recent recognitions include the 2020 National Science Foundation (NSF) CAREER Award, a 2019-2020 Research Excellence Award, as well as a 2019-2020 Teaching Excellence Award from the University of Houston's Cullen College of Engineering, 2019 National Academy of Engineering's U.S. Frontiers of Engineering Symposium, and the 2016 IEEE-USA New Face of Engineering, an award for engineers aged 30 and younger. Moreover, earlier this year, Faghih was featured by the IEEE Women in Engineering Magazine's "Women to Watch" section. ■

Rajiv Laroia honored with IEEE Alexander Graham Bell Medal

Alumnus **Rajiv Laroia** (EE Ph.D. 1992; EE M.S. 1989), won the 2020 IEEE Alexander Graham Bell Medal "for contributions to cellular wireless data systems."

At the University of Maryland, Laroia was advised by Nariman Farvardin, a joint ECE and ISR faculty member who would later become ECE department chair, Dean of the A. James Clark School of Engineering, Senior Vice President and Provost of the University of Maryland, and President of Stevens Institute of Technology in Hoboken, N.J. (2011-present).

After receiving his Ph.D., Laroia worked as a technical staff member for AT&T Bell Labs and its successor Lucent Technologies Bell Labs for eight years. He then founded and was Chief Technology Officer (CTO) of Flarion Technologies in 2000. It was at Flarion where he developed the OFDMA broadband wireless technology (now LTE) for which this medal is being awarded. Flarion was acquired by Qualcomm in 2006, and Laroia became a senior vice president there. In 2011 Laroia moved to Sonus Networks before founding The Light Company in Far Hills, New Jersey, in 2013. Today he serves as its Founder and CTO.

Laroia serves on the Advisory Board of the ECE Department. He was inducted into the Clark School's Innovation Hall of Fame in 2006 for "significant advances in telephone and mobile wireless communications."

The IEEE Alexander Graham Bell Medal was established in 1976 by the IEEE Board of Directors to commemorate the centennial of the invention of the telephone. The medal provides recognition for outstanding contributions to telecommunications, and is sponsored by Nokia Bell Labs.

The medal is bestowed annually at IEEE's Vision Innovation Challenges (VIC) Summit and Honors Ceremony in mid-May. This year, the ceremony was cancelled because of the novel coronavirus pandemic. Instead, honorees are being recognized through online promotions that showcase each recipient's contributions and their role in advancing technology for the benefit of humanity. ■

Donald H. Willis Inducted into Innovation Hall of Fame

The A. James Clark School of Engineering at the University of Maryland inducted **Donald H. Willis** ('62, electrical engineering) into its Innovation Hall of Fame (IHOF) on November 12, 2019.

Willis was honored for authoring numerous inventions that were applied to manufacture commercial television receivers that led the transition from analog television receivers into 21st-century digital television receivers.

Born and raised in Washington, D.C., Willis graduated with high honors from UMD in 1962 with a bachelor's degree in electrical engineering. That same year, he joined the RCA Corporation in Indianapolis, Indiana, as a circuit design engineer. At RCA, he worked on vacuum tube color TV sets and played a large role in the conversion of television sets to solid state circuitry.

While at RCA, Willis received his master's degree in electrical engineering from Purdue University in 1968. He was employed at RCA—which was acquired by General Electric and then by Thomson Multimedia—for more than 40 years before becoming an independent consultant in 2004. Thomson Multimedia presented Willis with several awards for outstanding inventions used in the television industry. He is the only Thomson Inventor to ever receive a 100 Patents Award. He accumulated more than 170 issued U.S. and European patents during his career, and his most recent patent was issued in 2016.

Major areas of impact of his work included the development of color TV receivers employing picture tubes, early development of VCRs, development of DVD players, Ferro resonant power supplies, and display development. His work contributed to the heavy and sustained innovation put to use by the electronics industry during this historic period, particularly for the conversions to solid state implementation and use of integrated circuits, the development of new displays, and new delivery using video compression. ■

UMD Mourns Passing of Innovation Hall of Fame Inductee and Alumnus, George J. Laurer

The University of Maryland mourns the loss of George Joseph Laurer, a 1951 graduate in electrical engineering and inventor of the Universal Product Code (UPC). A funeral was held on December 9, 2019 for Laurer, who died on December 5 at his home in Wendell, North Carolina. He was 94.

A 36-year veteran of the International Business Machines Corporation (IBM) who retired in June of 1987, Laurer was the holder of 25 patents. He was also the author of 20 published Technical Disclosure Bulletins. During his career, IBM recognized and rewarded him for many technical innovations. He received the prestigious Raleigh, North Carolina, Inventor of the Year award in 1976. In 1980 he was honored with IBM's Corporate Technical Achievement award for his work on the Universal Product Code proposal that was issued in 1970 by McKinsey & Co. and Uniform Grocery Product Code Council, Inc. The ubiquitous bar code allows retailers to identify products and prices as they are scanned, leading to fewer pricing errors and stronger inventory records. In 2011, IBM recognized Laurer during the company's centennial celebration as a contributor to one of the company's 100 iconic moments.

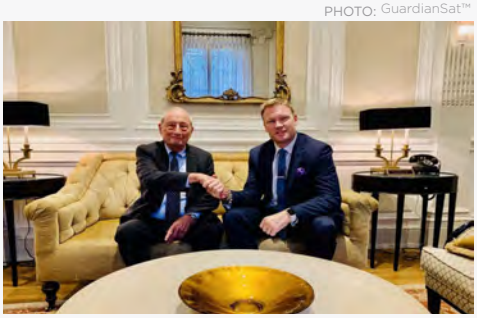
Laurer was inducted into the Clark School's Innovation Hall of Fame in 1991. A few years later, the 25th anniversary of his invention was celebrated at the Smithsonian National Museum of American History. Laurer was also inducted into the University of Maryland Alumni Hall of Fame in 2000. He recently received the prestigious Clark School of Engineering's 125th Anniversary Medal on November 21, 2019.

Laurer was born September 23, 1925, in New York. Before joining IBM, he earned a B.S. in electrical engineering from the University of Maryland in 1951. He came to the University after having served in World War II and attending a technical school to learn radio and TV repair. Upon completion of his first year at the technical school, his instructor convinced him that he should not continue that course of study, but that he should go to college.

Laurer was preceded in death by his wife, Marilyn Slocum Laurer. He is survived by his daughter Debra Laurer Cook of Clayton, North Carolina; son, Craig G. Laurer of Danbury, Connecticut, son, Mark K. Laurer of Lexington, Kentucky, son, Jonathan H. Laurer (Tanya) of Raleigh, North Carolina; grandchildren, Nigel F. Laurer, Jasper H. Laurer, India, Europa, Dubravka Zoe Laurer; great grandchildren, Xaelia, Victoria, and Zachary Laurer. ■

Robert Briskman Starts New Project to Attack Space Debris

PHOTO: GuardianSat™



The formation of GuardianSat™ by University of Maryland Alumnus Robert Briskman (M.S. '61) and former U.S. Air Force Officer Christopher Rohe, was announced on August 13, 2020. The company aims to develop and commercialize a system to protect orbiting satellites as well as improve space awareness in this growing field. As the co-founder of Sirius Satellite Radio, Briskman contributes an extensive background in satellite telecommunications. After 24 years in the Air Force, Rohe will bring experience as an Executive and Program Manager and Acquisition Officer, having overseen missile systems development programs. Rohe is a graduate of the Air Force Academy and Harvard's Kennedy School of Government.

A 2010 inductee into the Clark School's Innovation Hall of Fame, Mr. Briskman received a bachelor of science degree in engineering from Princeton University in 1954, and a master's degree in electrical engineering from the University of Maryland in 1961. He went on to direct satellite telecommunications systems at COMSAT and NASA before developing the technology for satellite radio and creating Sirius Satellite Radio in 1991. He is currently the Technical Executive at Sirius XM. In addition, Briskman is a Fellow of both IEEE and American Institute of Aeronautics and Astronautics (AIAA). He has been inducted into the Space Foundation, the Consumer Electronics Association and the International Astronautical Federation. He holds numerous patents and has authored more than 70 technical papers. ■

Filiz Yesilkoy Joins University of Wisconsin–Madison

Filiz Yesilkoy (Ph.D. '12, M.S. '10) joined the University of Wisconsin-Madison's Department of Biomedical Engineering in January 2020 as a tenure track assistant professor. Dr. Yesilkoy's research interests are in nanotechnology, biophotonics, and the design and fabrication of photonic and electronic devices.

At Maryland, Dr. Yesilkoy was advised by ECE Professor Emeritus **Martin Peckerar**. She was a Clark School of Engineering Future Faculty Fellow and President of the Women in Electrical and Computer Enigneering (WECE) program.

Following her Ph.D. at Maryland, Dr. Yesilkoy was a visiting research associate at the University of Tokyo in Japan and she has been a postdoctoral researcher at the Ecole polytechnique federale de Lausanne (EPFL) in Switzerland since 2013. ■

Dipankar Maity Joins University of North Carolina at Charlotte

Dipankar Maity (Ph.D. '18), joined the Electrical and Computer Engineering faculty of the University of North Carolina at Charlotte as a tenure-track assistant professor this fall.

At Maryland, Maity was advised by Distinguished University Professor **John Baras**.

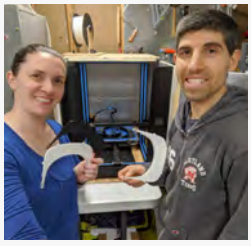
Currently, Maity is concluding his time as a postdoctoral fellow working with Pangiotis Tsiotras in the Dynamics and Control Systems Laboratory at the Georgia Institute of Technology. Maity's research is broadly focused in controls, multi-agent-systems, robotics and cyber-physical systems.

As a student, Maity was honored with the Clark School of Engineering Distinguished Graduate Fellowship, the UMD Graduate School's Outstanding Graduate Assistant Award, and the ECE Outstanding Teaching Assistant award. ■

ECE Alumni Help Fight COVID-19

3D-Printed Face Shields for Hospitals

Hobie Cohen ('04, electrical engineering), a systems engineer with Lockheed Martin, and his wife, Alicia, have been producing face shields at home to help the community. Their mission started out as a simple idea—Hobie had read a number of articles about 3D printers being used to produce PPE. He began by contacting hospitals in the area to see if workers could use 3D printed face masks. A doctor at Holy Cross Hospital in Silver Spring, Maryland, said what they really needed were face shields, so Hobie worked with the doctor to approve materials and a design that would meet the requirements for the Holy Cross Hospital System. They settled on a design made of a 3D printed head piece, a 3-hole punched plastic report cover for the shield, and non-latex rubber bands to hold the face shield securely in place.



Thanks to an immediate flood of volunteers and donations, they were able to create and donate more than 2,000 face shields in two and half weeks. Since then, their team has grown to more than 20 volunteers, donated more than 7,000 face shields, and has been able to supply PPE to 24 organizations across the country. ■

Turning Breast Pumps into Ventilators

Inspired to help healthcare facilities fight COVID-19, **Alex Scott** ('18, electrical engineering) and his team of four engineers, have been repurposing used breast pumps. Their innovation consists of reversing the suction that is created by the pumps, and developing them into an "intermittent positive pressure ventilation" device that safely replicates the job of a ventilator

The potential benefit of repurposing breast pumps is that they are readily available. Thousands of mothers likely have an old one stored away and would be more than willing to donate it. With additional safety measures added, the team can rebuild a pump in about four hours, at a fraction of the cost of a traditional ventilator. This type of ventilator would not be as effective as some of the highly sophisticated ventilators needed by some patients, but for less serious cases they could be used, allowing the more advanced models to be freed up for the patients most in need. ■

ECE Names 2020 Distinguished Alumni

The Electrical and Computer Engineering (ECE) Department held the ninth annual ECE Distinguished Alumni Award presentation on October 29. This year's virtual ceremony honored Mr. George Barnes, Dr. Jie Chen, Dr. Alan Pue, Dr. Amit Roy-Chowdhury, and Dr. Anuja Sonalker, for their leadership and meritorious contributions to the field of engineering, their humanitarian efforts, and the application of their engineering education to other disciplines.

George C. Barnes received a BS in Electrical Engineering from the University of Maryland in 1986. Joining the National Security Agency (NSA) in 1987, he rose through the ranks and in 2017 became Deputy Director. His technical education underpinned a broad mix of technical and organizational leadership experiences, including two overseas tours of duty, leadership of a global special deployments organization, leadership of NSA's intelligence collection organization, and leadership of NSA's workforce support directorate encompassing human capital management, security, and facilities management.

As Deputy Director, he acts as the NSA's chief operating officer, responsible for guiding strategy implementation, directing operations, formulating policy, and maximizing NSA's impact through engagement with counterpart leaders across the U.S. national security arena. A certified Cryptologic Engineer, Barnes has been recognized with a National Intelligence Medal of Achievement, the NSA Ann Caracristi Award for Operations & Production Excellence, an NSA Meritorious Civilian Service Award, an Intelligence Community Leadership Collaboration Award, and Distinguished & Meritorious Executive Presidential Rank Awards. For the 2020 ECE Distinguished Alumni Award, Barnes was nominated by ECE Chairman Joseph JaJa.

Jie Chen is a professor with the Electrical and Computer Engineering Department of the University of Alberta, Canada. From the University of Maryland, he received his Ph.D. in 1998 in Electrical Engineering. Before joining the University of Alberta, he worked for Bell Labs at Murray Hill and as an assistant professor at Brown University. Chen is the Director of the BINARY Lab (Biology, Information Science, and Nanotechnology Applications and Research Laboratory). His research focuses include biomedical circuits and system-on-chip designs, micro-/nano-fabricated microfluidic lab-on-a-chip biosensors, and artificial intelligence in healthcare. He has received international recognition with his design of a miniaturized ultrasound device for intra-oral dental tissue formation, which was reported in many news and media productions worldwide (such as Reader's Digest) and received Health Canada approval in 2016 while U.S. FDA approval is in process. He also helped establish Bell-labs' spin-off company. The company focused on the development of fourth-generation wireless communication systems. It was acquired in 2005 by QUALCOMM.

In addition to his work at the university level, Chen is active as an IEEE Fellow, as well as a Fellow of the Canadian Academy of Engineering. Positions with IEEE have included the technical committee chair of IEEE Therapeutic Systems and Technologies of the IEEE Engineering in Medicine and Biology Society, and steering committee member for the IEEE Journal of Translational Engineering in Health and Medicine. He has received many best paper/poster/invention awards. He has also received some major recognitions, such as the Killam Professorship Award 2015-2016, a high honor for outstanding contributions in teaching, research and community service at a Canadian University, as well as the McCalla Professorship Recipient 2016-2017, one of the highest honors to a professor at the University of Alberta. Chen was recommended for the 2020 ECE Distinguished Alumni Award by Dr. Ray Liu.

Alan Pue was nominated for the 2020 ECE Distinguished Alumni Award by Dr. John Baras. Pue recently retired as Chief Scientist, Air and Missile Defense, after a 45-year career with the Johns Hopkins University Applied Physics Laboratory (JHU/APL). After receiving a B.S. and M.S. from Cornell, he then earned his Ph.D. in Electrical Engineering from the University of Maryland in 1981. During his career at JHU APL, Pue made significant contributions to the field of

guidance navigation and control for missile systems, as well as other control system designs and analysis applications such as automated transportation systems and space telescope pointing. He was awarded a patent for a wideband interferometer system for a U.S. Navy ship defense missile, and was considered an expert in GPS and inertial navigation system integration applying to both Navy and Air Force weapon system development.

Prior to his most recent position, Pue held an impressive array of positions, including Supervisor of the Guidance, Navigation and Control Group in the Air and Missile Defense Department, and Director of the Interceptor Knowledge Center for the Missile Defense Agency. Over the years, he gained international experience and recognition by working with Japan as the primary technical lead for the development, analysis, and testing of alternative defense system concepts. He also led missile guidance studies as part of a NATO ship defense missile concept, working with military leaders and scientists from Great Britain, Spain, Netherlands, and Germany. In addition, Pue has long been committed to education and has developed and taught courses for the Johns Hopkins University Whiting School of Engineering, as well as a professional short course called "Advanced Integration of GPS and INS" for Navtech Seminars, Inc.

Amit Roy-Chowdhury earned his Ph.D. in Electrical Engineering in 2002. He is currently Professor and Chair of the Department of Electrical and Computer Engineering at the University of California Riverside, where he also serves as Director of the Center for Research in Intelligent Systems. He is a leading researcher in the fields of computer vision and image processing, and machine learning. His major contributions to the field include visual analysis in camera networks resulting in optimization of collected data used in tracking targets across a network of cameras, and machine learning from limited data resulting in an enhancement of inherent structure in the data and used applications related to computer vision, multimedia, and robotics.

Roy-Chowdhury was nominated for the 2020 ECE Distinguished Alumni Award by his former Ph.D. advisor, Dr. Rama Chellappa. He is an active participant in many areas beyond his university position. He regularly collaborates with a variety of academics, small businesses, and large corporations. As an IEEE Fellow, he has served multiple roles with the organization's Signal Processing and Computer societies, including Senior Associate Editor of IEEE Transactions on Image Processing, and member of the IEEE Image, Video, and Multidimensional Signal Processing Technical Committee. He is the author of the book Camera Networks: The Acquisition and Analysis of Videos over Wide Areas, and he has done extensive work on facial recognition in art that has been featured on a PBS/National Geographic documentary and in The Economist. His recent paper on joint video-text retrieval received the Best Paper Award at the Association for Computer Machinery International Conference on Multimedia Retrieval in 2018.

Anuja Sonalker earned an M.S. in Computer Engineering from North Carolina State University, then received her Ph.D. in Electrical Engineering from the University of Maryland. She was nominated for the 2020 ECE Distinguished Alumni Award by her Ph.D. Advisor, Dr. John Baras. Sonalker has gained national and international recognition as the Founder, CEO and Chief Technologist of STEER Tech, LLC, an autonomous vehicle company focusing on improving autonomous functions in a sustainable, scalable, secure, and affordable way. STEER Tech has developed technology for self-parking cars. Able to be used in specially designed parking lots, this technology uses a mobile phone app that can be installed to any standard car, works with the car's existing systems, and is cybersecure. The company has partnered with and completed successful field tests with Ford and General Motors and plans to expand operations in Asia then the United States and Europe. Locally, Sonalker's company, which is based in Columbia, Maryland, has partnered with the Maryland Department of Transportation to test "Automated Valet Parking" Technology at BWI Marshall Airport and Dorsey Run MARC Station parking lots.

Prior to launching her own company, Sonalker was Vice President of Engineering and Operations for TowerSec, an automotive cybersecurity company. She also led advanced research for the Automotive Security Group in the Cyber Innovation Unit at Battelle. Outside of leading her company, she participates as the co-chair of the Systems Engineering committee of the ISO-SAE Joint International Standard on Automotive Cybersecurity Framework, serves on the board of directors of the Economic Development Authority of Howard County, and was recently appointed to the A.J. Clark School of Engineering Board of Visitors. In addition, Dr. Sonalker is involved with mentoring programs for young women and high school students interested in pursuing careers in engineering and STEM. ■

Darryll J. Pines Named 34th President of The University of Maryland, College Park

The University System of Maryland (USM) Board of Regents has appointed **Darryll J. Pines**, Ph.D., as the 34th president of the University of Maryland, College Park (UMD).

Pines has spent 25 years on the College Park campus and is Dean of the University's A. James Clark School of Engineering. His appointment began on July 1, 2020.

Pines served as Dean and Nariman Farvardin Professor of Aerospace Engineering at the Clark School since January 2009. He first arrived at the Clark School in 1995 as an assistant professor and then served as Chair of the Department of Aerospace Engineering from 2006 to 2009.

As Dean of the engineering school with more than 6,000 students, Pines has led the development and implementation of a strategy to improve teaching in fundamental undergraduate courses and raise student retention, achieve success in national and international student competitions, place new emphasis on service learning and grand societal challenges, promote STEM education among high school students, increase the impact of research programs, and expand philanthropic contributions to the school.

Thanks in part to these efforts, the Clark School's one-year undergraduate retention rate and five-year graduation rate are 91 percent and 75 percent, respectively—which rank among the top at public flagship universities in the United States. In addition, Pines is currently leading an initiative to pilot a first-of-its kind, nationwide, pre-college course on engineering principles and design. The pilot program, Engineering For US All (E4USA), will test the effectiveness of a standardized educational curriculum across multiple states. The course, made possible through a $4 million National Science Foundation grant, is intended to eventually provide the equivalent of placement credit for an introductory college course.

"The Board is delighted to welcome as president of our flagship institution a leader of the caliber of Dr. Pines," Board of Regents Chair Linda Gooden said. "The University of Maryland, College Park is a world-class institution, and Dr. Pines brings to the position a wealth of experience. He knows intimately the strengths of the faculty, the energy of the students, and the circle of legislative and philanthropic support both in the State of Maryland and beyond. I can't think of a better person to build on the excellence at the University and take it to even higher levels. I know I speak for the entire board when I say we've found precisely the right person for this important job—College Park will indeed be in good hands."

Pines succeeds President Wallace Loh, Ph.D., J.D., who has led UMD since 2010. ■

Robert Briber Named Interim Dean of Clark School

Professor **Robert Briber** has been named Interim Dean of the University of Maryland's A. James Clark School of Engineering, effective April 1, 2020. Briber replaced Professor Darryll J. Pines, who began his new role as 34th President of the University of Maryland, College Park on July 1.

Briber brings exceptional administrative experience to his new role of Interim Dean of the Clark School. For the past five years, Briber has served the college as Associate Dean for Research. Under his leadership, the Clark School's research expenditures reached their highest level in history. He has also contributed to a number of strategic partnerships with industry and government, and helped to grow the number Faculty Early Career Development (CAREER) awards put forth by the National Science Foundation (NSF), Defense Advanced Research Projects Agency (DARPA), National Aeronautics and Space Administration (NASA), and other agencies. Additionally, Briber has overseen major renovation and capital projects in the college, including planning and construction for the E.A. Fernandez IDEA (Innovate, Design and Engineer for America) Factory.

Prior to his current position, Briber served for 12 years as Chair of the Clark School's Department of Materials Science and Engineering. During his time as Chair, the department's undergraduate enrollment increased by more than 250 percent, research expenditures more than doubled, and for the first time the department reached the top 25 in the U.S. News & World Report graduate rankings. ■

corporate partner SPOTLIGHT

ECE's Seven Year Partnership with leidos

Leidos, a Fortune 500® information technology, engineering, and science solutions and services company, aims to solve the world's toughest challenges in the defense, intelligence, homeland security, civil, and health markets. Headquartered in Reston, Virginia, Leidos is on a mission to make the world safer, healthier, and more efficient. The company's name, "Leidos," is coined from the word "kaleidoscope," and the company has embodied the meaning of the name in their ability to bring together solutions from many different angles. Since joining the Electrical and Computer Engineering (ECE) Corporate Affiliates Program in 2013, Leidos has been a major contributor to various ECE initiatives and the program's goal of educating engineers of the future.

Leidos is an active sponsor of ECE master's students and conducts important research with ECE faculty. For example, currently they are teamed up with ECE Professor John Baras on his research on machine learning. Recently, Leidos has joined the Quantum Technology Center to support development of advanced quantum capabilities relevant to their customers.

In addition, the company holds technical talks, hosts internship programs, and is a top employer of ECE students. In each of the past three years, Leidos hired more than 100 Maryland students—largely as a result of the dynamic partnership between the company and the University of Maryland (UMD). Leidos has also supported, hosted, or attended more than 25 events annually at UMD since joining the ECE Corporate Affiliates Program.

"The strong alliance between Leidos and the University of Maryland has allowed both entities to learn and grow, while contributing to the futures of some of our nation's most qualified engineers," said Dr. Jim Cantor, Leidos chief of performance excellence and strategic partnerships. "As a proud alumnus of the university, I am excited to see the growth that has stemmed from this alliance and look forward to the innovative collaboration still to come."

Dr. Cantor serves on the ECE Advisory Board, the A. James Clark School of Engineering Board of Visitors, and was recently named a UMD foundation trustee. Leidos remains committed to higher education and mentoring the workforce of the future. This dedication to lifelong learning spans beyond the ECE department and includes corporate sponsorship of the Clark School of Engineering Corporate Partners program, the computer science department and Clark Hall. As a true partner, ECE and UMD as a whole look forward to future interactions and events with the company. ■

James Cantor Named University Foundation Trustee

James Cantor ('81, M.S. '84), executive vice president and performance excellence and strategic partnership officer for Leidos, has been added to the University of Maryland College Park Foundation Board of Trustees. His term began July 1.

As a trustee, he will help grow the level of philanthropic support for the University, oversee the investment and distribution of private funds, serve as an ambassador on behalf of the foundation and the University, and advise University leadership.

Cantor joined SAIC/Leidos in 1990, and before taking his current role in 2019, served in roles such as chief technology officer, national security sector chief engineer, and corporate chief engineer. A former principal engineer for Computational Engineering, he was a research fellow at the Naval Research Laboratory and worked at the Department of the Army Ballistic Missile Defense Program Office. *This story originally appeared on Maryland Today.* ■

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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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