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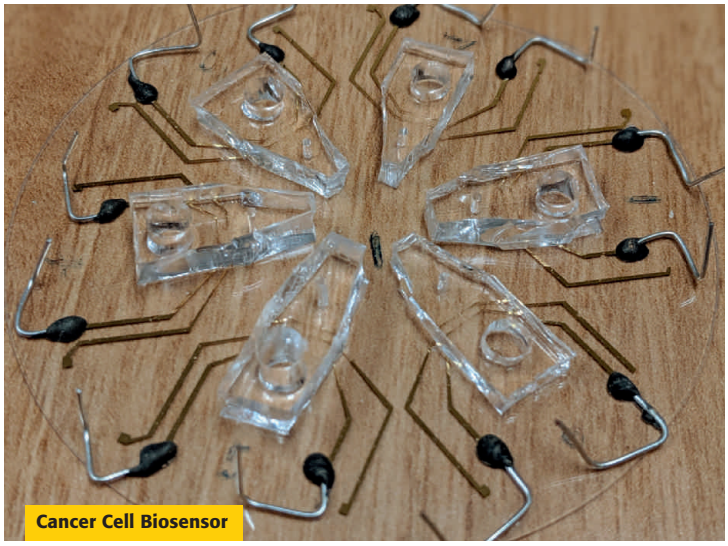
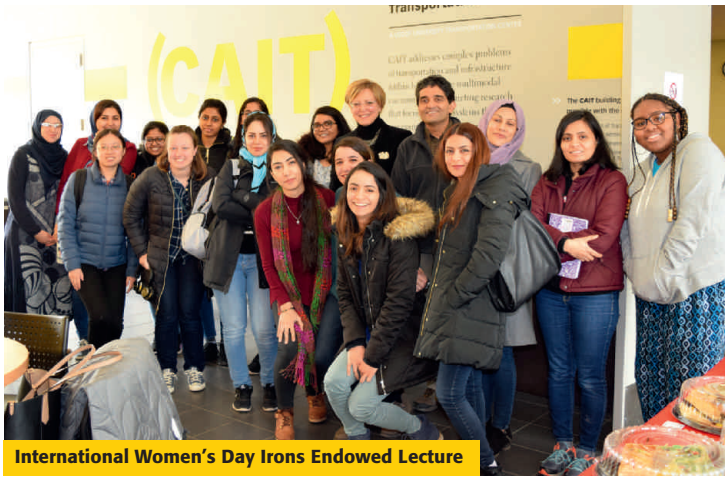
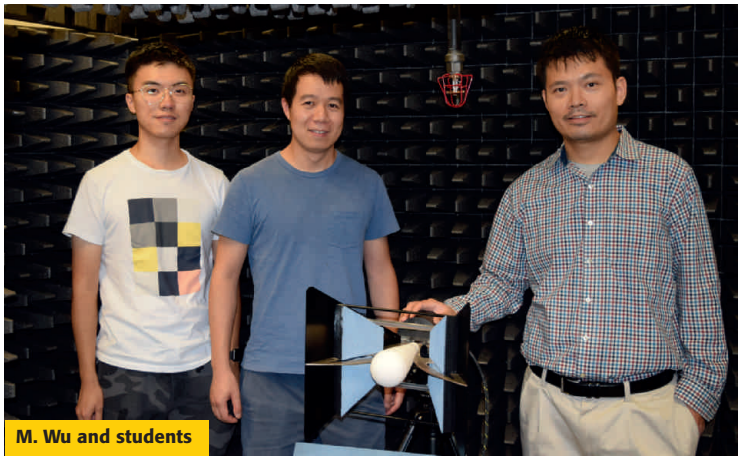
Rutgers University School of Engineering | Department of Electrical and Computer Engineering | 2019

Capstone 1st Place Winners


Cancer Cell Biosensor



International Women's Day Irons Endowed Lecture


M. Wu and students


S. Zonouz receives PECASE award at the White House

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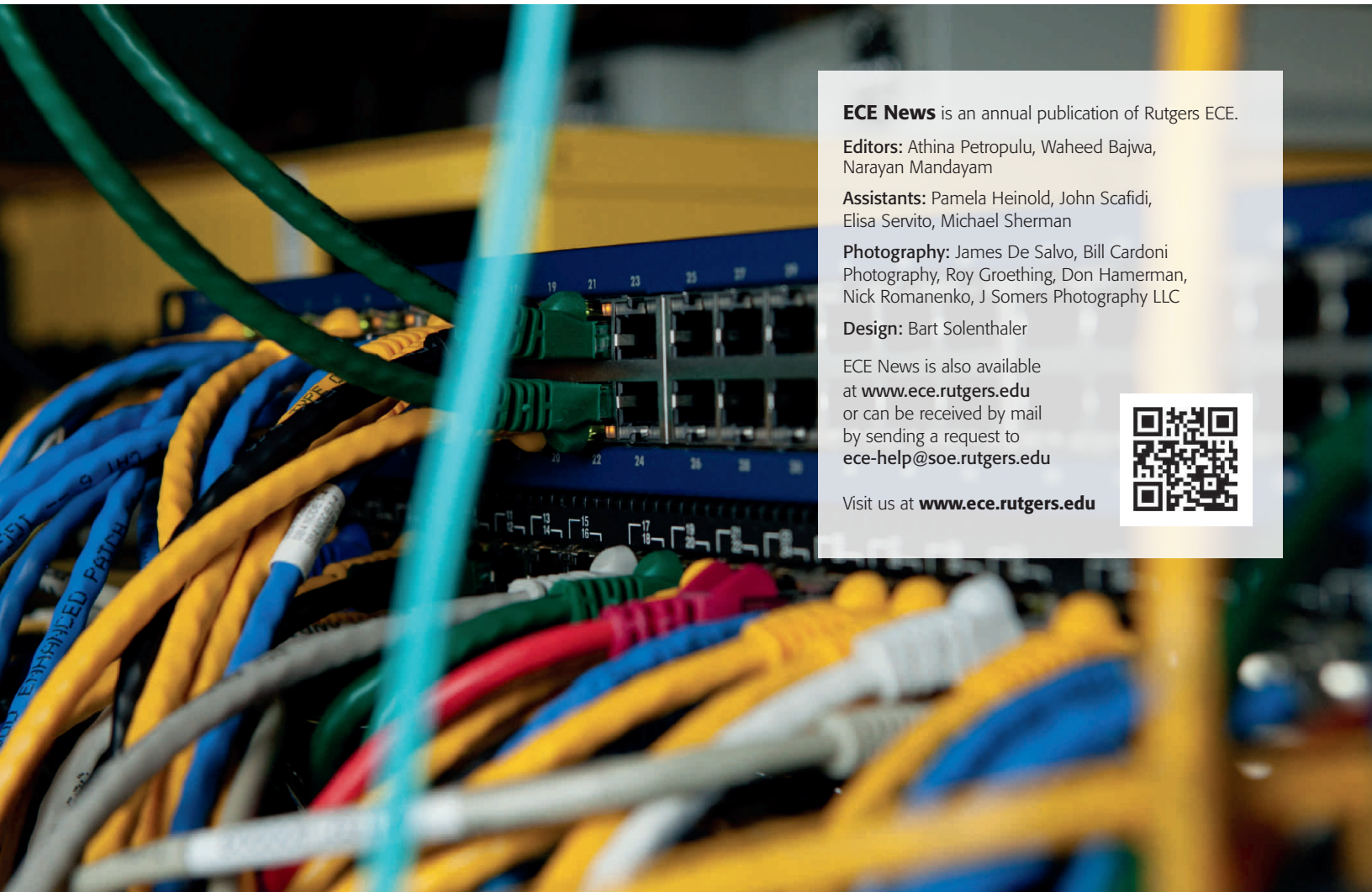

ECE News is an annual publication of Rutgers ECE.

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message from the Chair


N. Mandayam

As I commence the first year of my 2nd term as Chair, it is my pleasure to share with you some exciting news about my department during this past academic year. Our department continues to see an influx of highly talented faculty members contributing expertise in important emerging areas. This year we welcomed 2 new Assistant Professors: Dr. **Yuqian Zhang** (an expert in computer vision), and Dr. **Sumati Sehajpal** (an expert in electronic circuits and controls). This makes it 9 new tenure-track and teaching faculty members we have welcomed to the department in the last 3 years, strengthening our footprint in areas such as computer vision, signal and information processing, security, privacy, cyberphysical systems, bioelectrical engineering, machine learning and high performance computing.

Our faculty and students continue to make ECE one of the most vibrant departments at Rutgers, creating a community that fosters excellence in education and research. This excellence is reflected in the remarkable successes and outstanding achievements of our students and faculty members alike. Highlights include Professor **Athina Petropulu** (named Fellow of the American Association for the Advancement of Science), Professor **Yicheng Lu** (named the School of Engineering Faculty of the Year), Professor **Salim El Rouayheb** (named the A. Walter Tyson Endowed Assistant Professor), Professor **Mehdi Javanmard** (2018 NSF CAREER Award), Professor **Michael Wu** (2019 DARPA Young Faculty Award) and Professor **Saman Zonouz** (2019 PECASE Award from the U.S. White House). Professor **Grigore Burdea**'s research on using virtual reality for rehabilitation won two best paper awards at international conferences. Professor **Yingying Chen**'s research on suspicious object detection using WiFi was featured on CBS TV, and Professor **Janne Lindqvist**'s research on password security was featured on PBS TV. Like the year before, this year too was marked with a large number of external grants.

An ECE graduate team led by doctoral student **Sumit Maheshwari** along with master's students **Aayush Shah** and **Mohit Sheth** won first place at the Juniper Network and Comcast Software Defined Network (SDN) Throwdown competition. In addition, ECE students amassed a large number of recognitions, including a "Samsung Breakthroughs That Matter" award at the MIT Hacking Medicine Grand Hack 2019 (**Mengmei Ye**), Best Demo Award at the 2019 IEEE International Conference on Sensing, Communication and Networking (**Vidyasagar Sadhu** and **Mehdi Rahmati**), IEEE COMSOC Phoenix ISS Scholarship (**Neelakantan Krishnan** and **Chen Wang**), Chancellor's Leadership Award (**Tahsina Sanam**), and Fellowship in the Rutgers PreDoctoral Leadership Development Academy (**Hafiz Imtiaz**). ECE undergraduate students were again shining on the national stage – senior **Michael Edwin** won first place for his research project that applied electromagnetic waves in the detection of human vital signs and human tracking at the 6th Annual Black Doctoral Network Conference, senior **Jonathan Scott** received the National Defense Science and Engineering Graduate (NDSEG) Fellowship that will fund his graduate studies at Princeton, and junior **Marissa Navarro-Jauregui** was selected for the prestigious Brooke Owens Fellowship that recognizes outstanding women engineers intending to pursue a career in aerospace.

Consistent with this excellence, ECE student enrollment remains the highest in the School of Engineering, with our undergraduate enrollment across sophomore, junior and senior years at over 820, and the incoming graduate student class size at around 90 students. Our international program with a top tier university in China continues to flourish bringing in excellent students and we have expanded such partnerships to a second university. ECE students are also highly sought after by employers from a broad spectrum of industry, with the fundamentals that students are exposed to here making them versatile and productive employees from day one.

This was a great year for our alumni, whose amazing success is a source of inspiration to our students and faculty. Our department has produced outstanding scholars, industry leaders, entrepreneurs. You can meet some of them on pages 29-30.

In our pursuit of excellence the support of our alumni and friends is essential. I would like to thank everybody who supported us this past year. Through this support we were able to supplement startup packages of new faculty, provide student fellowships, support student travel to conferences and maintain state-of-art laboratories.

I am very proud of the accomplishments highlighted in this newsletter. Please visit us next time your travels bring you to our area, to experience up close the vibrancy of this department.

Sincerely,

Narayan Mandayam
Distinguished Professor and Chair

ECE Numbers

38
Faculty

4
Part-Time Lecturers

800
Undergraduate Students

266
Graduate Students

115
PhD Students

Space:
40,000 sq. ft.

ecefaculty

Waheed U. Bajwa
Associate Professor
NSF Career Award, ARO YIP Award
Research Interests: High-dimensional inference and inverse problems, compressed sensing, statistical signal processing, wireless communications, and applications in biological sciences, complex networked systems, and radar & image processing.

Grigore Burdea
Professor
NSF Initiation Award
IEEE Virtual Reality Career Award
Research Interests: Virtual rehabilitation, telerehabilitation, haptics virtual reality.

Yingying (Jennifer) Chen
Professor and Associate Undergraduate Director
NSF Career Award, Google Faculty Research Award, NJ Inventors Hall of Fame Innovator Award
Research Interests: Smart healthcare, internet of things (IoT), smart safety systems, cyber security and privacy, large-scale sensing data analysis.

Kristin Dana
Professor
NSF Career Award
Research Interests: Computer vision, pattern recognition, machine learning, convex optimization, novel cameras, camera networks, computer graphics, robotics, computational photography, illumination modeling.

Salim El Rouayheb
Assistant Professor
NSF Career Award, Google Faculty Research Award
Research Interests: Information Theory, Distributed Storage Systems and Networks, Distributed Coded Data, Data Secrecy and Wireless Networks.

Zoran Gajic
Professor and Graduate Director
Research Interests: Power control of wireless networks.

Hana Godrich
Associate Teaching Professor
Research Interests: Distributed power systems, energy resources management and storage, energy efficiency, statistical and array signal processing, resorce allocation optimization, distributed detection and estimation with application to smart grid, microgrids, and active sensor networks.

Marco Gruteser
Professor
Peter D. Cherasia Faculty Scholar
NSF Career Award
ACM Distinguished Scientist
Research Interests: Location-aware systems, pervasive computing systems, privacy and security, mobile networking, sensor networks and performance evaluation.

Umer Hassan
Assistant Professor
Research Interests: Biosensing, point of contact medicine, microfluidics, global health.

Mehdi Javanmard
Associate Professor
NSF Career Award
Research Interests: Nanobiotechnology, BioMEMS, Point of care diagnostics, Biomarker detection, Microfluidics, Electrokinetics, Applications of nanotechnology to medicine and biology.

Shantenu Jha
Associate Professor
NSF Career Award
Research Interests: High-performance and distributed computing, computational and data-intensive science and engineering, large-scale cyberinfrastructure for science & engineering.

Janne Lindqvist
Associate Professor
NSF Career Award
Research Interests: Systems security and privacy, mobile systems, social computing, context-aware communication, and human factors in computing systems

Yicheng Lu
Distinguished Professor
IEEE Fellow
Research Interests: Microelectronics material and devices.

Richard Mammone
Professor
National Academy of Inventors
Research Interests: Communications pattern recognition, neural networks, signal processing, technology commercialization, processes involved with the innovation of new technology.

Narayan Mandayam
Distinguished Professor & Department Chair
Peter D. Cherasia Faculty Scholar and Associate Director of WINLAB, IEEE Fellow, Distinguished Lecturer of IEEE
Research Interests: Cognitive radio networks and spectrum policy radio resource management for smart city, privacy in IoT.

Ivan Marsic
Professor
Research Interests: Mobile computing, software engineering, computer networks.

Sigrid McAfee
Associate Professor Emeritus
Research Interests: Defects in semiconductors, nanotechnology, financial engineering.

John McGarvey
Assistant Teaching Professor
Research Interests: Design and simulation of power electronic systems, control system modeling via both the classic and modern state-space techniques, and the design and testing of motor control systems.

Sophocles Orfanidis
Associate Professor
Research Interests: Statistical and adaptive signal processing, audio signal processing, electromagnetic waves and antennas.

Peter Meer
Distinguished Professor Emeritus
IEEE Fellow, AMiner Most Influential Scholar
Research Interests: Statistical approaches to computer vision.

Laleh Najafizadeh
Associate Professor
Research Interests: Functional brain imaging, brain connectivity, diffuse optical brain imaging, electroencephalography, cognitive rehabilitation, circuit design and microelectronics, ultra low-power circuits for biomedical applications, data converters, system on chip, wireless IC design.

Jorge Ortiz
Assistant Professor
Research Interests: Machine Learning for cyber-physical systems, Intelligent infrastructure systems, smart health applications

Athina Petropulu
Distinguished Professor
IEEE Fellow, NSF Presidential Faculty Fellow, Distinguished Lecturer of IEEE, AAAS Fellow
Research Interests: Statistical signal processing, blind source separation, cooperative protocols for wireless networks, physical layer security, MIMO radar, compressive sensing

Dario Pompili
Associate Professor
NSF Career Award, ONR Young Investigator Award, DARPA Young Faculty Award
Research Interests: Wireless ad hoc and sensor networks, underwater acoustic communications, underwater vehicle coordination, team formation/steering, task allocation, thermal management of datacenters, green computing, cognitive radio networks, dynamic spectrum allocation, traffic engineering, network optimization and control.

Lawrence Rabiner
Professor Emeritus
IEEE Fellow, National Academy of Engineering, National Academy of Sciences, IEEE Kilby Medal, IEEE Piore Award, IEEE Millennium Medal
Research Interests: Digital signal processing, digital signal processing, speech recognition, speech analysis, speaker recognition, and multimedia.

Dipankar Raychaudhuri
Distinguished Professor & Director of WINLAB
IEEE Fellow
Research Interests: Future network architectures and protocols, wireless systems and technology, dynamic spectrum access and cognitive radio, experimental prototyping and network research testbeds.

Peddapullaiah Sannuti
Professor Emeritus
IEEE Fellow
Research Interests: Simultaneous internal and external stabilization of linear time-invariant systems in the presence of constraints is pursued. Internal stabilization is in the sense of Lyapunov while external stabilization is in the sense of L_p l_p stability with different variations, e.g. with or without finite gain, with fixed or arbitrary initial conditions with or without bias.

Anand D. Sarwate
Assistant Professor
NSF Career Award, A. Walter Tyson Award
Research Interests: Machine learning, distributed systems, and optimization, with a focus on privacy and statistical methods.

Sumati Sehajpal
Assistant Teaching Professor
Research Interests: Electrical circuit theory and analysis, Class E and Class G RF power amplifiers

Deborah Silver
Professor & Executive Director PSM Program
Research Interests: Scientific visualization, computer graphics.

Emina Soljanin
Professor
IEEE Fellow and Distinguished Lecturer
Research Interests: Efficient, reliable, and secure storage and transmission networks, coding, informatin, and queueing theory.

Predrag Spasojevic
Associate Professor
Research Interests: Communication and information theory, signal processing and representation, cellular and wireless Lan systems, adhoc and sensor networks.

Maria Striki
Assistant Teaching Professor
Research Interests: Analysis/design/optimization of data algorithms, statistical analysis, mathematical modeling, big data, data analytics, social networks, information systems, cybernetics, wireless-mobile-ad-hoc-cellular networks, (secure) routing, mobile computing, network-computer security.

Matteo Turilli
Assistant Research Professor
Research Interests: Parallel and distributed Computing, software design for distributed infrastructures, computer science computer ethics.

Wade Trappe
Professor & Associate Director of WINLAB and Undergraduate Director
IEEE Fellow
Research Interests: Multimedia security, wireless security, wireless networking and cryptography.

Sheng Wei
Assistant Professor
NSF Career Award
Research Interests: Hardware security and trust, hardware-enabled system security, heterogeneous system architecture and security, mobile and multimedia systems.

Chung-Tse (Michael) Wu
Assistant Professor
NSF Career Award, DARPA YFA
Research Interests: Microwave and millimeter wave components and circuits, passive and active antennas and arrays, electromagnetic metamaterials, wireless sensors and RF systems.

Roy Yates
Distinguished Professor & Associate Director of WINLAB
IEEE Fellow
Research Interests: Resource management in wireless systems, dynamic spectrum access and spectrum regulation, information theory for wireless networks and future internet architectures.

Bo Yuan
Assistant Professor
Research Interests: Algorithm and hardware co-design, machine learning, signal processing systems, embedded and IoT systems.

Yuqian Zhang
Assistant Professor
Research Interests: Computer vision, machine learning, signal processing.

Jian Zhao
Professor
IEEE Fellow, NSF Initiation Award
Research Interests: Silicon Carbide (SiC) semiconductor devices, SiC JFETs, BJTs, MOSFETS, GTOs, high efficiency smart power integrated circuits, SiC sensors, UV and EUV detectors, SiC inverters/converters.

Saman Zonouz
Associate Professor
NSF Career Award, PECASE Award
Research Interests: Networks security and privacy, trustworthy cyber-physical critical infrastructures, embedded systems, operating system security, intrusion detection and forensics analysis, and software reverse engineering.

Michael Caggiano
Professor Emeritus
Expertise: Electrical Packaging, microwave packaging, analog circuit design, digital circuit and logic design.

Richard Frenkiel
Part-time Lecturer
National Medal of Technology, Alexander Graham Bell Medal, National Academy of Engineering, National Academy of Inventors, Draper Prize
Expertise: Cellular Systems, Wireless Networks

Phil Southard
Part-time Lecturer
L3Harris Technologies
Expertise: Field programmable gate arrays (FPGA's), computer hardware, digital design, programmable logic, application specific integrated circuits.

Shiyu Zhou
Part-time Lecturer
Expertise: design and analysis of data structures and algorithm, computational complexity, information theory.

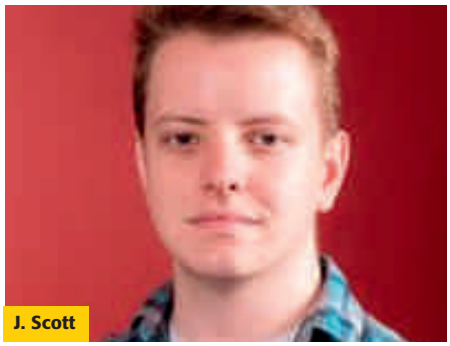
studentnews

Cong Shi recipient of Siemens sponsored Graduate Assistantship

C. Shi

Siemens Corporation has announced that ECE PhD student **Cong Shi** will be the recipient of a Siemens-sponsored calendar year Graduate Assistantship. Shi's appointment is from July 1, 2019 to June 30, 2020. The total award package is worth $64K. The goal of Cong's research is to apply machine learning techniques to solve security problems in mobile computing. In particular, the research focuses on machine-learning based contactless user authentication on the Internet of Things (IoT) devices. Cong is currently pursuing Ph.D. degree with the Department of Electrical and Computer Engineering at Rutgers University, supervised by Prof. **Yingying (Jennifer) Chen**. His research interests include Machine Learning, Cyber Security and Privacy, Mobile Sensing and Healthcare.

ECE senior Jonathan Scott receives NDSEG Fellowship



J. Scott

ECE senior **Jonathan Scott** has received the National Defense Science and Engineering Graduate (NDSEG) Fellowship. This highly competitive graduate fellowship is for a period of up to three years, and covers full tuition, mandatory fees and a graduate stipend. The NDSEG Fellowship is sponsored by the Air Force Office of Scientific Research (AFOSR), the Army Research Office (ARO), and the Office of Naval Research (ONR) under the Office of the Assistant Secretary of Defense (OSD) for Research and Engineering.Jonathan's research proposal "Design of Integrated Electrical and Acoustic Thin Film Biosensor Array" is based on his Slade Scholars thesis under Prof. **Yicheng Lu**'s supervision. The Slade Scholars Program at Rutgers is designed specifically for outstanding undergraduate students to do research under a faculty advisor for undergraduate credit and to complete an honors senior thesis. Jonathan's research on this new sensing technology has promising potential as a clinical and research tool for diagnostics and monitoring of antibiotic activity and antibiotic drug resistance. Jonathan has decided to attend Princeton University to pursue his Ph.D in the area of devices and photonics.

M. Navarro-Jauregui

Marissa Navarro-Jauregui has been selected for the Brooke Owens Fellowship

ECE senior **Marissa Navarro-Jauregui** has been selected for the Brooke Owens Fellowship. Marissa will be working with HawkEye360, a space-based global intelligence network that identifies and locates objects that emit RF signals used in communications, navigation and operations.

ECE researchers win Best Demo Award at the 2019 IEEE International Conference on Sensing, Communication and Networking (IEEE SECON)

Associate Professor **Dario Pompili** and ECE Ph.D. students **Vidyasagar Sadhu** and **Mehdi Rahmati** have won the Best Demo Award at the 2019 IEEE International Conference on Sensing, Communication and Networking (IEEE SECON) that was held in Boston, MA. IEEE SECON provides a unique forum to exchange innovative research ideas, recent results, and share experiences among researchers and practitioners in wireless networks, mobile systems, and the Internet of Things. Their demo paper titled "MOSFET-based Ultra-low-power Realization of Analog Joint Source-Channel Coding for IoTs" addresses sensing applications such as in the Internet of Things (IoTs), where the sensing phenomenon may change rapidly in both time and space, and require sensors that consume ultra-low power (so as to be able to collect data continuously and not lose temporal and spatial resolution) and have low costs (for high density deployment). A novel encoding based on Metal Oxide Semiconductor Field Effect Transistors (MOSFETs) is proposed by the team to realize Analog Joint Source Channel Coding (AJSCC), a low-complexity communication technique to compress two (or more) analog signals into one with controlled distortion.

Chen Wang and Neelakantan Nurani Krishnan recipients of IEEE COMSOC Phoenix ISS Scholarship 2019

ECE Graduate students **Chen Wang** and **Neelakantan Nurani Krishnan** were selected as the recipients of IEEE Communications Society Phoenix ISS Award for 2018-2019 academic year. Each student received an award of $3,000. The IEEE Communications Society Phoenix ISS Award was established to encourage engineering student to participate in professional activities. Awards are to be given to full-time or part-time students to cover expenses for students to attend the International Switching Symposium, or other IEEE Communications Society Conferences.

Students become Faculty

Chen Wang

Chen Wang graduated with his Ph.D. degree in Electrical and Computer Engineering from Rutgers University in Summer 2019. Before that, he worked in Wireless Information Network Laboratory (WINLAB) under the supervision of Prof. **Yingying Chen**. After graduation, he joined the Computer Science Department at Louisiana State University as a tenure-track assistant professor. His research interests include cybersecurity and privacy, smart healthcare, mobile sensing and computing, Internet of Things and machine learning. He is the recipient of three Best Paper Awards from the top security conferences, IEEE Conference on Communications and Network Security (IEEE CNS) 2018, IEEE CNS 2014 and ACM Conference on Information, Computer and Communications Security (ASIACCS) 2016. He also received the Best Teaching Assistant of the Spring 2018 Semester at Rutgers University and IEEE COMSOC Phoenix ISS Award in 2019. From 2014 to 2019, his research studies have been widely reported by over 150 media outlets, including Rutgers News, IEEE Spectrum, NSF Science 360, Fortune, ABC News, MIT Technology Review, etc.

Chen Wang said "I would like to thank the ECE Dept. and WINLAB at Rutgers for helping me to stand out in the competitive academic job market. Rutgers ECE has exceptional faculties, who are always willing to help the students to strengthen their background in Electrical and Computer Engineering and guide them to success. Our research group has given me many golden research opportunities to work on cybersecurity and mobile sensing problems. Moreover, Rutgers ECE and WINLAB provide world-class resources in both education and research. During my PhD study, I was able to improve myself in every aspects including strengthening my technical knowledge, gaining teaching and presentation skills, enhancing programming capabilities and forming analytical thoughts. I enjoyed the years I spent at Rutgers and will never forget them."

Jian Liu

Jian Liu received his Ph.D. degree from Rutgers University, under the supervision of Prof. **Yingying Chen**. After graduation, he joined the Department of Electrical Engineering and Computer Science at the University of Tennessee, Knoxville as a tenure-track assistant professor in Fall 2019. His research interests include Mobile Sensing and Computing, Cybersecurity and Privacy, Smart Healthcare and Machine Learning.

During his Ph.D. study, he has published one book chapter, more than 35 papers in premium conferences and peer-reviewed journals including ACM MobiCom, ACM MobiSys, ACM MobiHoc, ACM CCS, IEEE INFOCOM, ACM UbiComp, and IEEE TMC, etc. He holds 4 US patents, two of which have been licensed to industrial companies. He is the recipient of two Best Paper Awards from IEEE SECON 2017 and IEEE CNS 2018, Best-in-session Presentation Award from IEEE INFOCOM 2017, Best Poster Award Runner-up from ACM MobiCom 2016 and 2018. He is also the recipient of ECE Best Teaching Assistant Award and Research Excellence Award in 2018 from Rutgers University. His research has received wide press coverage, including BBC News, Yahoo News, MIT Technology Review, NBC New York, WCBS TV and Voice of America TV, etc.

Jian Liu said "I am so grateful that I had the opportunity to pursue my PhD study at Rutgers University. The ECE department and WINLAB at Rutgers provide tremendous resources to support our study and research. The faculties in the department and WINLAB are very knowledgable and helpful. My advisor worked with me on many aspects in my research work and provided me great guidance and help. I enjoyed every moment that I spent at Rutgers, and this would be the most memorable time in my life and motivates me to move forward in an academic career."

Shunqiao Sun

Shunqiao Sun received the Ph.D. degree in Electrical and Computer Engineering from Rutgers, The State University of New Jersey in Jan. 2016, under supervision of Prof. **Athina Petropulu.** He received the M.S. degree from Fudan University in 2011 and B.E. degree from Southern Yangtze University in 2004, both in Electrical Engineering. From 2016 to 2019, he was with the radar core team of Aptiv, Technical Center Malibu, CA where he had worked on advanced radar signal processing and machine learning algorithms for self-driving cars. During his studies, he held internships at Mitsubishi Electric Research Labs (MERL), Cambridge, MA and Cisco Systems, Shanghai, China. Dr. Sun was awarded the 2015-2016 ECE Graduate Program Academic Achievement Award by Rutgers University. He is also the winner of 2016 IEEE Aerospace and Electronic Systems Society Robert T. Hill Best Dissertation Award for his thesis "MIMO Radars with Sparse Sensing". He is a Senior Member of the IEEE.

In Aug. 2019, Dr. Sun joined the Department of Electrical and Computer Engineering at The University of Alabama as a tenure track assistant professor. His research interests lie at the interface of statistical and sparse signal processing with mathematical optimizations, MIMO radar, machine learning, smart sensing for autonomous vehicles, radar remote sensing for global climate change and radio frequency sensing for digital healthcare.

S. Sun

Dr. Sun says "It's great experience to pursue Ph.D. study at the ECE department of Rutgers University. I was lucky to work with Prof. Athina Petropulu on radar signal processing projects which were funded by the Office of Naval Research and NSF. Prof. Petropulu has led me into the radar research field and given me tremendous research guidance. Rutgers provides great resource and facilities for graduate students. It's very convenient for students to take class in other departments or centers that would help their researches. For example, I had o pportunities to take three optimization courses at Rutgers Center for Operations Research (RUCTOR). Rutgers ECE department has exceptional faculties and the faculties and staff of ECE are always willing to help students. My Ph.D. study at Rutgers helped me to lay a solid foundation on radar signal processing theory, and more importantly gave me tremendous training to be a scientific researcher. I am very grateful to Rutgers and I am proud to be one of Rutgers alumni".

Meet an ECE Student


C. Shi


F. Johnson


M. Rahmati


T. Petersen


A. Gupta

Cong Shi

I am a Ph.D. student in the department of Electrical and Computer Engineering, and my Ph.D. advisor is Prof. **Yingying Chen**. My research interests span Cyber Security and Privacy, Machine Learning, Mobile Sensing and Healthcare. I obtained my research experiences by working in WINLAB and Data Analysis and Information SecuritY (DAISY) lab led by Prof. Chen. I published a set of papers in premier venues including ACM MobiHoc, ACM SenSys, ACM MobiSys, ACM UbiComp, etc.

I have been selected to receive the Siemens FutureMakers Fellowship 2019. Our research proposal, "Machine Learning based User Authentication through Daily Activities Leveraging IoT Devices", is to apply machine learning techniques for contactless user authentication on the Internet of things (IoT) devices. IoT devices, such as smart refrigerator, smart TV, and voice assistant systems, usually require user authentication process to support various fundamental applications (e.g., access control, smart appliance interaction and customized services). Current user authentication systems mainly rely on either password or physiological biometrics such as fingerprints and iris, which usually require to install extra and dedicated devices. To perform the device-free user authentication, we propose to combine machine learning techniques and Wi-Fi measurements made available by smart devices and appliances (laptop, smart refrigerator) to identify users. I hope that the proposed research could advance the security of mobile and IoT devices and benefit a variety of emerging mobile applications.

In addition to my research work, I served as the Teaching Assistant of 16:332:573 Data Structure and Algorithm class with Prof. **Shantanu Jha** in Spring, 2019. I have learned how to effectively support an instructor and help students with their homework and exams through this opportunity. I gained valuable experiences from this course.

In the past years, my research group, WINLAB, and ECE department have provided me many supports in terms of research guidance and Ph.D. study knowledge. I would like to pursue my career as an educator and a researcher in the future. And the faculties, resources, and culture of Rutgers have provided great opportunities with me, helping me grow and achieve my goals. It is my great pleasure to share my experiences and future prospects with fellow students, and I hope my experiences could inspire them to pursue their careers in science and engineering.

Faith Johnson

I graduated cum laude in May 2019 with a Bachelor's degree in Electrical and Computer Engineering. During my freshman year, I got the opportunity to be a part of both the Honors College and Douglass Residential College. Both are communities of unique individuals that pushed me to expand my conception of my limitations. From the Honors College, I learned to question the status quo and go out of my way to make a positive impact in the world. From Douglass Residential College, I learned that my potential is not limited by the world's perception of me. These two lessons shaped the way I approached the rest of my time at Rutgers.

During my sophomore and junior years, I joined Eta Kappa Nu, the honors society for Electrical and Computer Engineering, and Theta Tau, a co-ed, professional fraternity. Through Eta Kappa Nu, I was able to tutor underclassmen. This was such a rewarding experience because I was able to give back to the ECE community and try to make the ECE journey a little easier for those who came after me. Theta Tau, where I served as Treasurer and Dance Marathon liaison, allowed me to serve the broader Rutgers community. Dance Marathon is a yearly event where student organizations raise money to support children with cancer, sickle cell, and other serious illnesses. As liaison, I organized fundraisers and tried to inspire enthusiasm for the cause.

I also got the chance to participate in an internship program at Bank of America. I interned there for three years and got to be a part of projects in a wide variety of areas from front end development, to regression testing, to machine learning. This internship had a direct hand in putting me on my current career path. During my senior year, I had the opportunity to take Professor **Dana**'s Robotics and Computer Vision course which vastly changed my perception of my major. It awakened a passion for the subject matter that I didn't know I had. Because of the skills I learned in this class and at my internship, I was able to get a research position in Professor Dana's lab focusing on the intersection of machine learning and computer vision. This research and my capstone project cemented my passion for computer engineering. This fall I will be pursuing a Master's degree in Computer Engineering here at Rutgers. I chose to stay at Rutgers because this university is at the intersection of all of my interests and played a great role in making me who I am today.

Mehdi Rahmati

I am a Ph.D. candidate in Electrical and Computer Engineering (ECE) at Rutgers University working with Prof. **Dario Pompili** in the Cyber-Physical Systems Laboratory (CPS Lab). Before joining the CPS Lab in 2013, I was a teaching faculty member in Iran from 2009 to 2013. My research interests lie primarily in the field of wireless

communications and networks. Currently, I conduct research to design novel algorithms, protocols, and systems for robust, reliable, and high-data rate multimedia transmissions in uncertain and extreme environments, such as underwater environment.

I have published more than 16 peer-reviewed conference and journal papers since 2013 (totally 24 papers). I have received the best demo award at the 2019 IEEE International Conference on Sensing, Communication and Networking (SECON), the best paper award at the 2017 IEEE International Conference on Mobile Ad-hoc and Sensor Systems (MASS), and the best paper runner-up award at the 2015 ACM International Conference on Underwater Networks and Systems (WUWNet). I am also the recipient of Rutgers ECE research excellence award in 2018, Rutgers School of Graduate Studies conference travel award in 2018 and 4 other National Science Foundation (NSF) conference travel awards. I have been assigned as a reviewer in more than 80 journal and conference papers in my field and have received 2 outstanding reviewer certificates from Elsevier Ad-Hoc Networks Journal and the Elsevier Journal of Parallel and Distributed Computing in 2016 and 2018, respectively. I have served as a technical program committee (TPC) member in 10 international conferences, including IEEE INFOCOM Workshop on Wireless Communications and Networking in Extreme Environments (WCNEE) in 2018 and 2019. I serve as the poster and demo chair at the 2019 ACM International Conference on Underwater Networks and Systems (WUWNet) in Atlanta, Georgia. I gave a talk at the 10th and 11th Annual Sustainable Raritan Conference, in 2018 and 2019, on the importance of using networked-robots for near-real-time water quality monitoring of the Raritan River. I was invited as a panelist to the NSF's Frontiers in Undersea Seafloor Science and Engineering Workshop (FUSE) which was hosted by the Northeastern University in Boston in 2018.

I am now a senior research assistant working on two NSF-funded projects in the CPS lab: "Reliable Underwater Acoustic Video Transmission Towards Human-Robot Dynamic Interaction" and "Enabling Real-time Dynamic Control and Adaptation of Networked Robots in Resource-constrained and Uncertain Environments". So far, I have mentored more than 30 undergraduate and graduate students in the CPS lab. Moreover, in summer 2018 and under the New Jersey Governor's School of Engineering and Technology (GSET) program, a group of 5 high school students explored underwater video signal transmission techniques in the CPS lab under my supervision and Prof. Pompili's guidance and won the best paper award at the 2018 IEEE MIT Undergraduate Research Technology Conference (URTC) which was hosted on MIT campus in Cambridge, Massachusetts.

Tim Petersen

I am an undergraduate senior majoring in Electrical & Computer Engineering. Since I transferred here in sophomore year, Rutgers SOE has been inviting, encouraging, and challenging. Upon entering Rutgers, I sought out a robotics program since I was involved in the First Tech Challenge Robotics in high school. My previous school did not have such a program, and I was relieved to find IEEE had a robotics division that had a subdivision of VEXU Robotics, an international robotics competition.

After getting involved in VEXU through competing and, also, through volunteering at local high schools by running their competitions, I decided to get more involved in VEXU and IEEE as a whole. The following year, I became the Engineering Governing Council Representative for IEEE and the Director of VEXU Robotics subdivision. In the spring, after effectively running the program and participating in EGC, our Director of Robotics graduated, and I was appointed to the position, overseeing our Micromouse and PacBot competitions. This year, I was elected President. In this position, I plan to reestablish our presence within SOE, create connections with our alumni, and develop our members within our robotics, machine learning, electronics, quad copter, and novice2expert coding divisions along with running our weekly professional development workshops.

To date, I have interned with the Naval Air Systems Command (NAVAIR) and Norfolk Southern Railroad. While an intern with the NAVAIR, I tested multiple Moriah Wind System configurations, which led to the system being installed on three Coast Guard ship classes. At Norfolk Southern, I maintained the life cycle of crossings, signals, and rail turnouts to ensure that everything was operating in a safe and consistent manner.

Upon completion of my undergraduate degree, I plan to continue my education at Rutgers with the combined M.S./B.S. program, studying for my masters in Systems Engineering. For the remaining summer, I will secure one more internship in order to develop my skills as an engineer and make myself more marketable as a contributor. I am looking forward to a productive year within IEEE and my final year as an undergraduate student.

Aarushi Gupta

I graduated in May 2019 with an Electrical Engineering degree. Throughout my time at Rutgers, I had been involved in various activities which ranged from technical to leadership-oriented positions. I was involved in various societies on campus such as Society of Hispanic Engineers, IEEE, AIAA, etc. With, one of my biggest accomplishment being, organizing the SHE-SWE-MEET Career fair for 2 consecutive years. Additionally, I have also been part of various community service committees which help get high school students involved with early college math and science programs.

Besides being involved in the community, I worked at VIZLAB under Dr. **Karen Bemis,** helping in data visualization of plumes found in the Atlantic Ocean using MATLAB. The research aided in a deeper understanding of these underwater volcanoes. I also served as a Learning Assistant under Professor **Bajwa** for his Digital Signal Processing class, I loved helping students understand the concepts which I enjoyed learning and answering any questions they might shy away from asking the professor. This experience was an eye-opener because it made me realize how much one's adaptability can affect a student's ability to grasp concepts, which is extremely important not only in academia but in the industry as well. The most challenging and exciting part of my time here was capstone design during senior year. I had the opportunity to have Professor **Petropulu** as our team's advisor. Throughout the semester, we worked in her lab to research and build a machine learning model which detected malware infected microcontrollers using EM waves. By creating concrete and realistic goals, seeking constant guidance from Professor Petropulu and the research students working in her lab, and researching on topics which aren't readily accessible, I was able to develop my problem-solving abilities and hone my interpersonal skills. This design project was rewarding after the final product came into fruition. Our project won 'Best in Innovation' award which made the hard work even more enjoyable.

Outside of Rutgers, I interned at Verizon as a Data Analytics and Artificial Intelligence Intern, it was an amazing experience to see how much my background as an ECE major helped in understanding the nitty gritty of huge projects when looking at them from a 1000 ft view. My time at Rutgers has been extremely rewarding and enlightening. Not only did I learn a lot about things that I never knew existed or how they worked, but I also had the opportunity to apply the skills and knowledge I took from classroom, to the outside world. After graduation I have been working at Raytheon as a Software Engineer. With all my experiences here, at Rutgers, I can confidently say that I'm not limited to one type of role as an engineer, but my skills are transferable to so many other engineering roles and are very valuable in the industry. Rutgers ECE gave me a leg up for which I'm very thankful because its reputation precedes itself. Moving forward, I hope to continue my education and work towards a master's degree after working in the industry for a few years.

ECE 2019 Capstone Program Highlights

Capstone design program, or engineering design projects, marks an important millstone in our ECE undergraduate students' education. The program offers students with an opportunity for a full-scale project development mimicking industrial environment that includes ideation, teamwork, budget and time constraints along with design challenges. This year, over 250 students participated in the program with 67 projects.

Faculty and industry advisors play a significant factor in supporting students with design and implementation of cutting-edge technology and research. Their efforts and support are key to the success of our capstone program and the students' learning experience. This year we had advisers from Harris, IBM, Optimal Solutions, and Interactions involved with our students' projects. These projects were partly industry driven and others were students' ideas cultivated by experience professionals. These collaborations add to the large spectrum of skills acquired through the capstone program.

This year's projects have a strong focus on social impact. Technologies to supports people with sight disabilities in home and outdoor were developed in the "Blind Walker" project (by Christopher Favorito, Mahmoud Bachir, Brendan Li, Quentin Lester; Adviser: Prof. Kristin Dana) and "VINS: Visually Impaired Navigation System" (by Varun Bhandari, Angeline Jacob, Niharika Mishra, Sai Singanamala; Adviser: Prof. Hana Godrich), and "Dynamic Text-to-Braille" (by Colter Mooney, Gunbir Singh, Kartikey Thapliyal; Advisor: Prof. Kristin Dana).

Tracking distracted driving and alerting motorcycles from dangerous obstacles were the focus of "Sentinel: A Distracted Driving Warning System" (by Faith Johnson, Brooks Tawil, Deepti Upmaka; Adviser: Prof. Kristin Dana) and "Motorcycle Obstacle Detection" (by Margaret Kirollos, Matthew Mann, Vincent Taylor, Michael Thumann; Advisor: Hubertus Franke, IBM).

Sustainability was in mind for the team which developed smart solutions such as "Smart Trash Can" (by Jake Rodin, Steven Coulter, Umama Ahmed, Yiwen Zhou; Adviser: Prof. Sheng Wei), "Smart Street" (by Mahmoud Emara, Michaela Csorny, Gavin Mckim; Adviser: Prof. Michael Caggiano), "Energy-Efficient Wireless Analog Sensors " (by Delbert Bauldock, Danny Romero, Kevin Zarazua; Advisers: Prof. Dario Pompili, Vidyasagar Sadhu), "SmartLite" (by Joseph Del Duca, Michael Spisak, Dax Dalwadi, Manthan Shah, Zeid Abdulrazeq; Adviser: Prof. Hana Godrich) and "Smart Fridge" (by Brian Lin, Gowthama Thangamathesvaran, Rendy Zhang, Nikhil Jiju; Advisor: John Chen, Interactions).

Medical and behavioral applications were of main interest in the "Cough Classifier Application" project (by: Sherif Salem, Anushka Desai, Hagar Elshentenawy, Esraa Abdelmotteleb; Adviser: Prof. Mehdi Javanmard) and "Bluetooth Enabled Habit Reversal Smart Device" (by Lucine Kelly, Alice Balashova, Kyowan Kim, Siddharth Musale; Adviser: Janne Lindqvist).

Safety and security were the main concern in "Emergency Ham: A Rapid Deployment Ham Network for Disaster Situations" (by Emilio Garcia, Vinay Shah; Adviser: Prof. Wade Trappe), "EM Based Intrusion Detection for IoT Devices" (by Aarushi Gupta, Nicholas Clark, Fahad Alghamdi; Advisers: Prof. Athina Petropulu), "UWB Radar System Design For Vital Sign Detection" (by Jonathan Scott, Salman Hoque, Mushfiq Atul, Taewon Kim; Advisor: Chung-Tse Michael Wu), and "SOS Beacon" (by Betina Tan, Shannon Flood, Jeremiah Jacinto, David Hom; Advisor: Professor Michael Caggiano).

Improving student's life was not overlooked, with some projects addressing gaps in students' services as in "Students Unite" (by Dafna Shochat, Joseph Coleman, Nicolas Croce, Malay Shah; Adviser: Prof. Hana Godrich), "Rutgers Transport on Google Home" (by Arti Patel, Smruthi Srikumar, Souvik Ganguly, Krupa Patel, Kishan Patel; Advisers: Prof. Maria Striki) and "RUCrowded" (by Corey Chen, Steven Adler, Jonathan Garner, David Zhang; Advisor: Prof. Roy Yates).

Projects ranged from software focus to hardware development. Examples include: "RISC-V Processor & Applications on FPGA" (by Oz Bejerano, Jonathan Colella, Alex Riveron, Birane I. Toure, Jimmy Wen; Advisers: Prof. Philip Southard, Manoj Viswambharan, Saurabh Singh, Greg Mueller; Harris) that implemented a system comprised of a RISC-V processor with an interactive terminal interface; "Data Set Crawler for Multilingual ASR Engine" (by Mo Shi, Zekun Zhang, Ziqi Wang, Chaoji Zuo, Duc Le; Adviser: Dr. Shahab Jalavand; Interactions LLC) focused on constructing data set for multilingual ASR engine;

The climax of the program is Capstone Expo day that was held this year on Wednesday April 24, 2019 in the Busch Students Center. In this event students' hard work, creativity, skills and knowledge are evaluated by a panel of industry and academia judges.

This year's panel of judges chose the top 10 ranking projects and additional three awards: Best in Innovation, Best in Research, and Best in Impact. The following judges participated this year: Chris Marty (Two Sigma), Don Bachman (ASCO Power Technology), Nikhil Shenoy (Siemens), Ed Cordero (JP Morgan), David Schmied (JP Morgan), Jason Becker (JP Morgan), Nagi Naganathan (Broadcom), Hubertus Franke (IBM), Michael Kornitas (Rutgers), Joe Rambala (Harris), Soyab Khatumbra (Harris), Mike Dolan (Harris), Phillip Southard (Harris), Teddy Brown (Verizon Wireless), Jon Pucila (Blackrock), Daniel Arkins (Blackrock), Samuel Ramrajkar (Mars), Shahab Jalalvand (Interactions LLC), Minhua Chen (Interactions LLC), Ludwig Randazzo (Juniper), Akanksha Pathak (Verizon), Gihan Oraby (U.S. Army), Richard Huber (AT&T), Donald Levy (AT&T), Stephen Wilkus (Spectrum Financial Partners), Bill Marushak (Lutron), Erivelle Calderon (Trumpf), Robert Menna (Trumpf), Nagi Naganathan (Broadcom), Jane Luo (Qualcomm), Harry Heinold (Argo AI), Corey Norton (Rutgers), Batoul Ahmad Taki (Rutgers), Fatemeh Koochkig (Rutgers), Salim El Rouayheb (Rutgers), and Muhammad Asad Lodhi (Rutgers). Their expertise, care, and insights were priceless in making the hard decisions for the top projects. Our judges were very impressed with the quality of the projects and commended our students' capabilities and enthusiasm.

The Capstone Expo event and students' awards were sponsored by Siemens, Harris, 7x24 Exchange Metro New York Chapter, JP Morgan Chase, Blackrock, and Interactions. We would like to thank our faculty, advisers, judges, staff, and sponsors for their commitment to this program and for making the capstone experience for our class of 2019 professionally effective and memorable

A full list of projects is available on the ECE site under **http://www.ece.rutgers.edu/capstone-design-2019.**

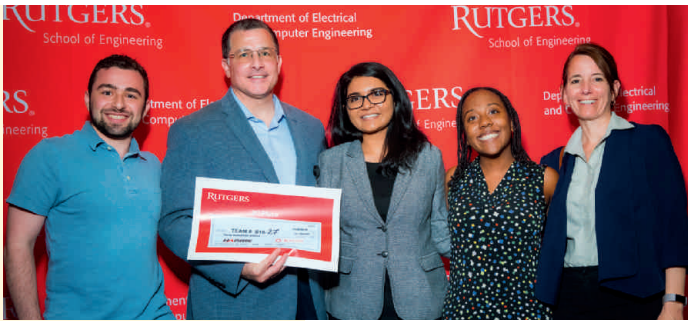
Congratulations to the class of 2019 for an exceptional capstone year!

This year's top ten awards winners

FIRST PLACE
(awarded $600, sponsored by Siemens)
Project S19-32: Blind Walker
Team members: Christopher Favorito, Mahmoud Bachir, Brendan Li, Quentin Lester
Advisor: Prof. Kristin Dana

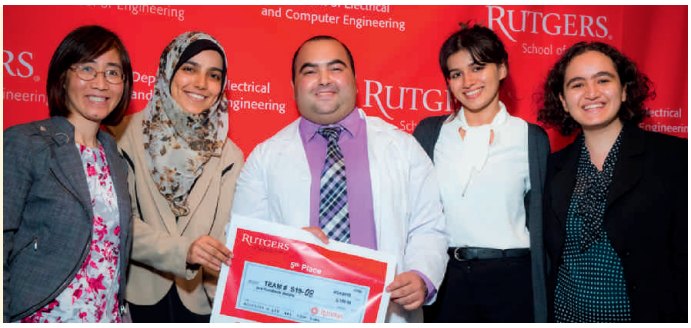
SECOND PLACE
(awarded $400, sponsored by JP Morgan Chase)
Project S19-18: VINS: Visually Impaired Navigation System
Team members: Varun Bhandari, Angeline Jacob, Niharika Mishra, Sai Singanamala
Advisor: Prof. Hana Godrich

THIRD PLACE
(awarded $300, sponsored by Harris)
Project S19-27: Sentinel: A Distracted Driving Warning System
Team members: Faith Johnson, Brooks Tawil, Deepti Upmaka
Advisor: Prof. Kristin Dana



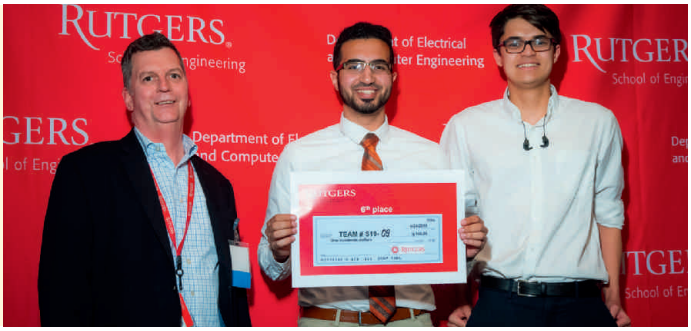
FOURTH PLACE ($100)
Project S19-36: Smart Trash Can
Team members: Jake Rodin, Steven Coulter, Umama Ahmed, Yiwen Zhou
Advisor: Prof. Sheng Wei

FIFTH PLACE ($100)
Project S19-08: Cough Classifier Application
Team members: Sherif Salem, Anushka Desai, Hagar Elshentenawy, Esraa Abedelmotteleb
Advisor: Prof. Mehdi Javanmard



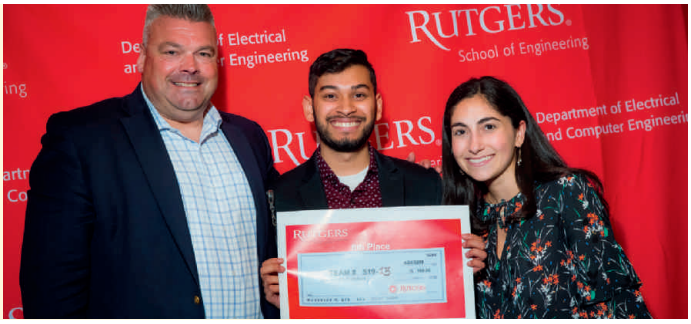
This year's top ten awards winners (continued)

SIXTH PLACE ($100)
Project S19-09: Smart Street
Team members: Mahmoud Emara, Michaela Csorny, Gavin McKim
Advisor: Prof. Michael Caggiano

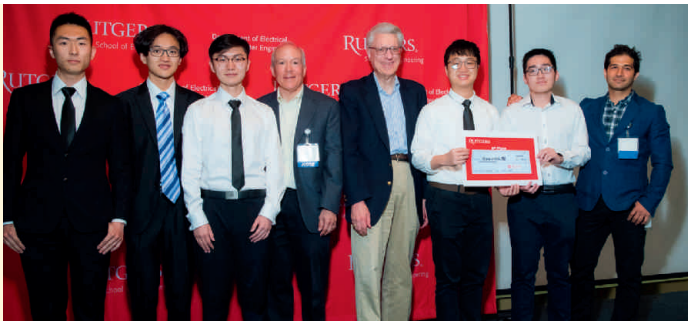


SEVENTH PLACE ($100)
Project S19-46: RISC-V Processor & Applications on FPGA
Team members: Oz Bejerano, Jonathan Colella, Alex Riveron, Birane I. Toure, and Jimmy Wen
Advisors: Prof. Phillip Southard, Manoj Viswambharan, Saurabh Singh, and Greg Mueller (Harris)

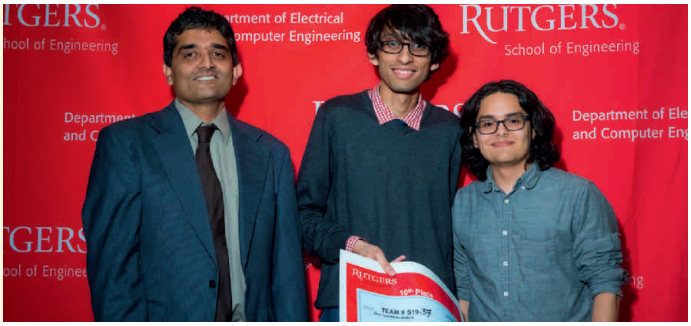
EIGHTH PLACE ($100)
Project S19-13: Bluetooth Enabled Habit Reversal Smart Device
Team members: Lucine Kelly, Alice Balashova, Kyowan Kim, Siddharth Musale
Advisor: Janne Lindqvist



NINTH PLACE ($100)
Project S19-38: Data Set Crawler for Multilingual ASR Engine
Team members: Mo Shi, Zekun Zhang, Ziqi Wang, Chaoji Zuo, and Duc Le
Advisor: Dr. Shahab Jalalvand (Interactions LLC)



TENTH PLACE ($100)
Project S18-37: Emergency Ham: A Rapid Deployment Ham Network for Disaster Situations
Team members: Emilio Garcia and Vinay Shah
Advisor: Prof. Wade Trappe

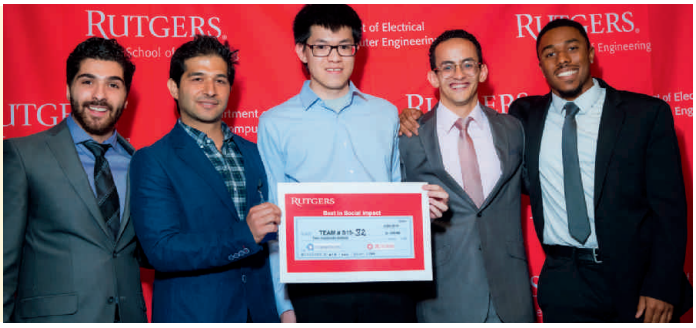


Capstone Special Award Winners

BEST IN INNOVATION AWARD
(awarded $200, sponsored by 7x24 Exchange)
Project S19-68: EM Based Intrusion Detection for IoT Devices
Team members: Aarushi Gupta, Nicolas Clark, Fahad Alghamdi
Advisor: Prof. Athina Petropulu

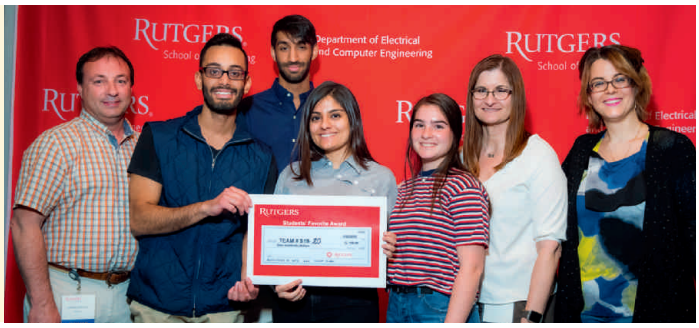
BEST IN RESEARCH AWARD
(awarded $200, sponsored by Siemens)
Project S19-38: Data Set Crawler for Multilingual ASR Engine
Team members: Mo Shi, Zekun Zhang, Ziqi Wang, Chaoji Zuo, Duc Le
Advisor: Dr. Shahab Jalalvand (Interactions LLC)

BEST IN SOCIAL IMPACT
(awarded $200, sponsored by Harris Corporation)
Project S19-32: Blind Walker
Team members: Christopher Favorito, Mahmoud Bachir, Brendan Li, Quentin Lester
Advisor: Prof. Kristin Dana



STUDENTS FAVORITE AWARD I
(awarded $200, sponsored by Siemens)
Project S19-39: Students Unite
Team members: Dafna Shochat, Joseph Coleman, Nicolas Croce, Malay Shah
Advisor: Prof. Hana Godrich

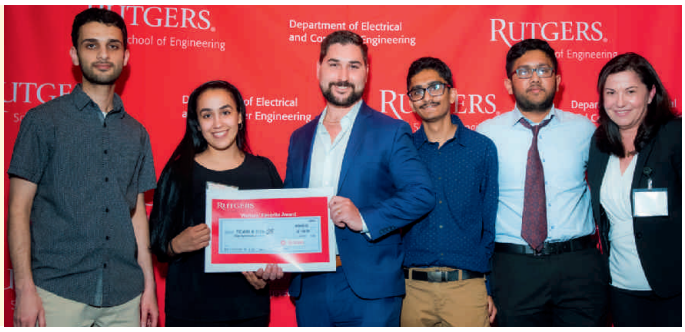
STUDENTS FAVORITE AWARD II
(awarded $200, sponsored by Siemens)
Project S19-20: Rutgers Transport on Google Home
Team members: Arti Patel, Smruthi Srikumar, Souvik Ganguly, Krupa Patel, and Kishan Patel
Advisor: Prof. Maria Striki



Capstone Special Award Winners (continued)

VISITORS FAVORITE AWARD I
(awarded $200, sponsored by Siemens)
Project S19-64: Energy-Efficient Wireless Analog Sensors
Team members: **Delbert Bauldock, Danny Romero, Kevin Zarazua**
Advisor: **Prof. Dario Pompili** and **Vidyasagar Sadhu**

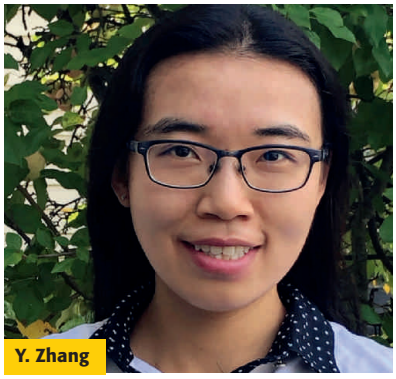
VISITORS FAVORITE AWARD II
(awarded $200, sponsored by Siemens)
Project S19-06: SmartLite
Team members: **Joseph Del Duca, Michael Spisak, Dax Dalwadi, Manthan Shah, Zeid Abdulrazeq**
Advisor: **Prof. Hana Godrich**



ECE Welcomes New Faculty


S. Sehajpal

Sumati Sehajpal received her PhD in Electrical and Computer Engineering from Rutgers University in the Spring of 2017. During the past two years, she has taught courses for Rutgers University as a Part Time Lecturer for both the Mathematics and Electrical and Computer Engineering departments. Prior to moving to the United States in 2008 she taught various electrical and electronic engineering courses from 2005 to 2007, working as a full time Lecturer at the Lovely Institute of Technology located in Jalandhar, Punja, India. She received her Master's in Electronics Product Design and Technology at the Punjab Engineering College located in Chandigarh, India in 2005 and her Bachelor's in Electrical Engineering from the Adesh Institute of Engineering and Technology in 2003. Her research interests include electrical circuit theory and analysis, the Class E and Class G RF power amplifiers, and the modern state-space based approach used to both model and analyze electronic systems.


Y. Zhang

Yuqian Zhang will join Rutgers ECE in Spring 2020. She is a postdoc scholar affiliated with the Department of Computer Science and the TRIPODS data science center at Cornell University. She received her PhD in Electrical Engineering from Columbia University in 2018, and her BS in Electrical Engineering from Xi'an Jiaotong University in 2011. Her research leverages physical models in data driven computations, convex and nonconvex optimization, solving problems in computer vision, machine learning, signal processing. She has been invited to participate in the EECS Rising Stars Workshop at Stanford University, and the Young Investigator Lecture Series at California Institute of Technology.

Cancer Device Created at Rutgers to See if Targeted Chemotherapy is Working

Artificial intelligence and biosensors can rapidly detect if live cancer cells remain after treatment

Rutgers researchers have created a device that can determine whether targeted chemotherapy drugs are working on individual cancer patients.

The portable device, which uses artificial intelligence and biosensors, is up to 95.9 percent accurate in counting live cancer cells when they pass through electrodes, according to a study in the journal Microsystems & Nanoengineering.

"We built a portable platform that can predict whether patients will respond positively to targeted cancer therapy," said senior author **Mehdi Javanmard**, an associate professor in the Department of Electrical and Computer Engineering in the School of Engineering at Rutgers University–New Brunswick. "Our technology combines artificial intelligence and sophisticated biosensors that handle tiny amounts of fluids to see if cancer cells are sensitive or resistant to chemotherapy drugs."

The device provides immediate results and will allow for more personalized interventions for patients as well as better management and detection of the disease. It can rapidly analyze cells without having to stain them, allowing for further molecular analysis and instantaneous results. Current devices rely on staining, limiting the characterization of cells.

"We envision using this new device as a point--of-care diagnostic tool for assessing patient response and personalization of therapeutics," the study says.

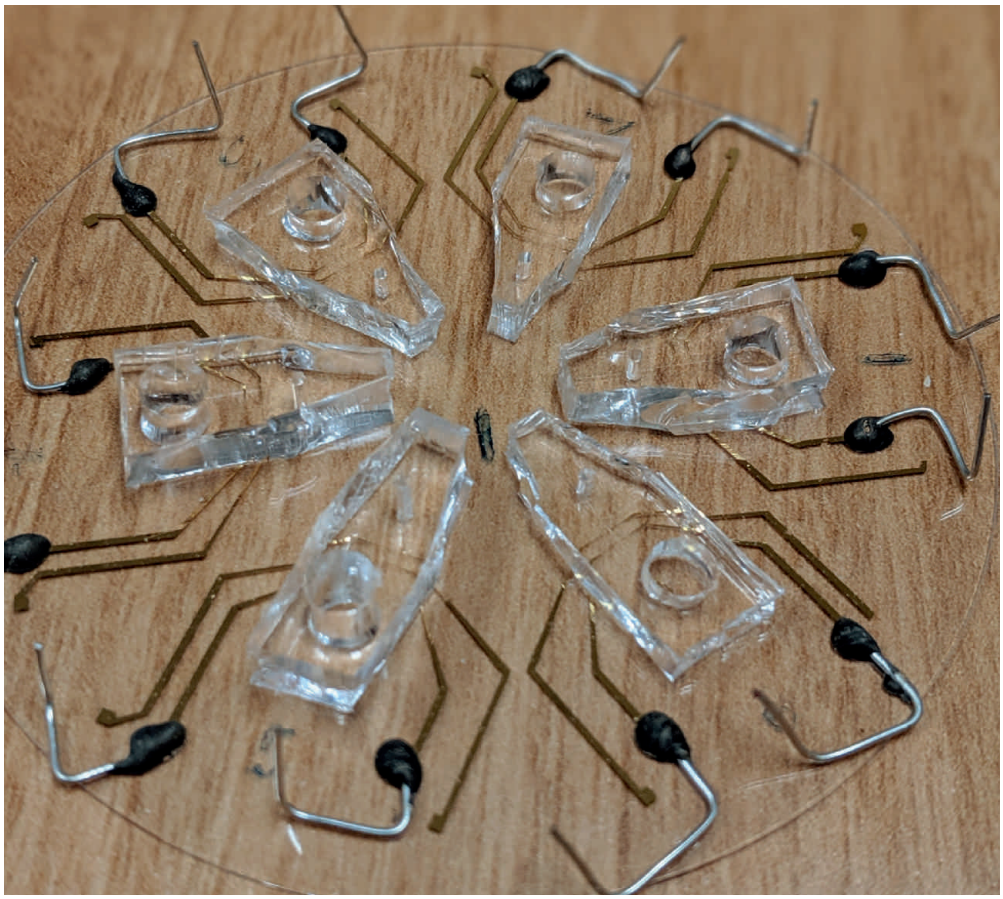
Treatment of cancer patients often requires drugs that can kill tumor cells, but chemotherapy destroys both tumor cells and healthy cells, causing side effects such as hair loss and gastrointestinal problems.

M. Javanmard

Co-author **Joseph R. Bertino**, a resident researcher at Rutgers Cancer Institute of New Jersey and professor at Rutgers Robert Wood Johnson Medical School, and his team previously developed a therapeutic approach that targets cancer cells, such as those in B-cell lymphoma, multiple myeloma and epithelial carcinomas. It binds a chemotherapy drug to an antibody so only tumor cells are targeted, and minimizes interaction with healthy cells. Patients will respond positively to this therapy if their tumor cells generate a protein called matriptase. Many patients will benefit while the side effects from standard chemotherapy are minimized. "Novel technologies like this can really have a positive impact on the standard-of-care and result in cost-savings for both healthcare providers and patients," Bertino said.

The Rutgers team tested their new device using cancer cell samples treated with different concentrations of a targeted anti-cancer drug. The device detects whether a cell is alive based on the shift in its electrical properties as it passes through a tiny fluidic hole. The next step is to perform tests on tumor samples from patients. The researchers hope the device will eventually be used to test cancer therapies on samples of patient tumors before treatment is administered.

The lead author was **Karan Ahuja**, who earned a master's degree at Rutgers. Co-authors include Gulam M. Rather, a postdoc at Rutgers Cancer Institute of New Jersey, and engineering doctoral students **Zhongtian Lin, Jianye Sui, Pengfei Xie** and **Tuan Le.**



This image shows six devices with biosensors to detect whether a cancer cell is alive when it passes through a tiny hole for fluids. The devices fit on a 3-inch wide piece of glass. Photo: Zhongtian Lin

An inspiring talk by a distinguished researcher and one of the first female fighter pilots on International Women's Day

On March 8, Prof. **Mary L. 'Missy' Cummings** of Duke University delivered a "Henry R. and Gladys V. Irons Endowed Lectureship" on a Machine Learning Approach to Modeling Human Interaction with Autonomous Systems.

Prof. Cummings is director of the Humans and Autonomy Laboratory at Duke University. She was a naval officer and military pilot from 1988–99, and one of the US Navy's first female fighter pilots. She is also a member of the US Department of Defense's Defense Innovation Board, a fellow for the American Institute for Aeronautics and Astronautics and a member of the Board of Directors for Veoneer, Inc. Her research interests include human supervisory control, human–unmanned vehicle interaction, human–autonomous systems collaboration, human–robot interaction, human systems engineering, and the ethical and social impact of technology.

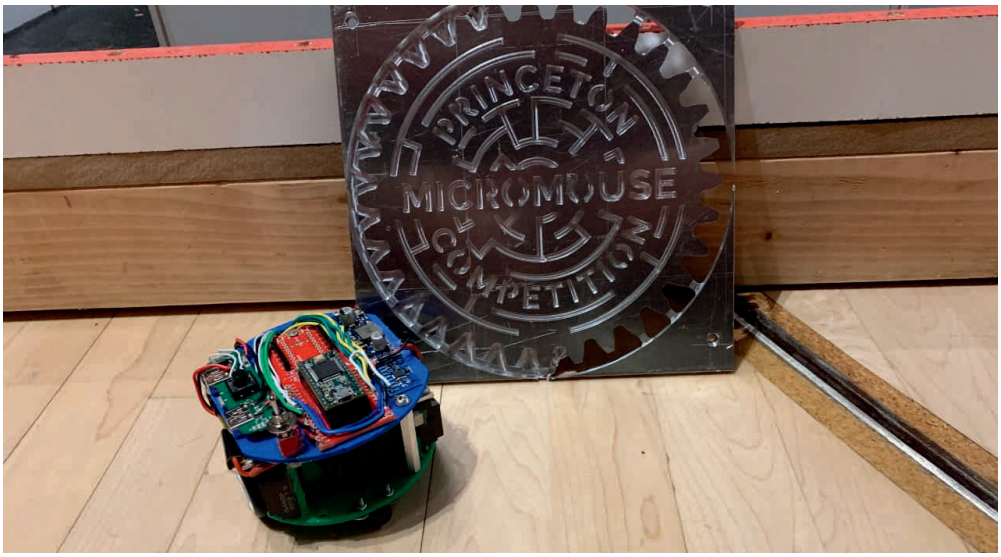
Prof. Cummings delivered an inspiring talk on her fighter pilot experience and how that experience influenced her research on human autonomous system interaction.

Following her talk, Prof. Cummings joined ECE female graduate students and faculty on an International Women's Day reception, during which she provided useful tips to our students on how to prepare for a job search, how to deal with implicit bias, and how to balance family and career.

Left to right: Profs. Emina Soljanin, Missy Cummings, Laleh Najafizadeh, Kristin Dana, Athina Petropulu

ECE Graduate students with ECE Chair Narayan Mandayam and ECE Professor Athina Petropulu

Rutgers IEEE Wins Awards at the 2019 Princeton Micromouse Competition



Rutgers IEEE competed at the 2019 Princeton Micromouse Competition and won the design competition coming in third in the maze solving competition. Congratulations to **Joe Jaeschke** and **Nicholas Clegg** for this achievement! Joe and Nick wrote the following to detail their design.

Micromouse is a robotics competition where a robot is designed to navigate a 16x16 square maze and solve it by starting in a corner and reaching the center of the maze. There are many challenges with solving this problem, like how a robot does not tend to drive perfectly straight and like to crash into walls, getting a robot to rotate at precise angles when it reaches a turn in the maze, and building a robot that can do all of this and still fit within 20cmx20cmx20cm cube. In order to solve these problems, we implemented a feedback loop controller called a PID controller that helped us take care of these real world problems. How this controller works is it looks at sensor data from the robot and compared the value it should be and the value that it currently is. Then if there is a difference in these values, it will change the speed of the motors of the robot in order for the robot to take on the proper trajectory. For example, if we want a robot to drive in a straight line, then we can use a sensor called a motor encoder to read the current rotation of one of the motors, and if the motor has rotated more than it is supposed to, then we can slow down the speed of that motor. A PID controller was used so our robot could drive in a straight line, and so it could rotate correctly in the maze. In order to to have a robot that could fit within the size requirements of the maze, we took advantage of 3D printing to create parts that would allow all of our components to fit snugly in one package.

Another challenge we faced with this competition was how to guide our robot so it would eventually reach the center of the maze. In order to accomplish this task an algorithm called flood-fill was used. The algorithm works by initially assuming there are no walls in the maze and assigning each square a value. The middle four squares of the maze are the goal and are assigned a value of zero. Then each square reachable in one movement of the robot gets a value of one, each square reachable in two movements gets a value of two and so on. Then all the robot needs to do is to transition to the neighboring square with the least value. However as the robot moves it will sense walls. With these added walls, some of the values will no longer be accurate and will need updating. The rule for this update is that every square is one more than the minimum of the neighbors. After updating the values of the neighbors, the robot can then move to the least valued neighbor. This process will continue until the robot reaches the goal. The path taken will not necessarily be the shortest path but it is a path that allows the robot to be in the maze the least amount of time. In order for the shortest path to be found, the entire maze would have to be known. To know the entire maze the robot would have to visit every square. Since the robot does not move perfectly straight or turn perfectly, the more it moves there is more error in its movement. Even with the strategies noted in the previous paragraph, it is best to spend as little time as possible searching for the center which is what the flood-fill algorithm accomplishes.

ECE Graduate Student Mengmei Ye wins "Samsung Breakthroughs That Matter" award at the MIT Hacking Medicine Grand Hack 2019


M. Ye

ECE PhD student **Mengmei Ye** working under the supervision of Assistant Professor **Sheng Wei** is part of a team that has won a "Samsung Breakthroughs That Matter" award at the MIT Hacking Medicine Grand Hack 2019 (http://grandhack.mit.edu/). The "Samsung Breakthroughs that Matter" awards were created to highlight the potential for partnerships between the United States Veterans Health Administration (VHA), industry, and academia in the cultivation of innovative entrepreneurs, who embrace Samsung hardware and software to assist the VHA with improving Veterans' quality of care and access to useful and innovative healthcare solutions for Veterans. Mengmei was a member of the team of researchers/practitioners from industry/academia/hospital/government that was recognized for a system concept they developed, called Simulacron, for being the most effective and transformative digital health solution with the potential to improve access to and quality of, cancer care for veterans. Simulacron employs deep learning to realistically simulate privacy-sensitive medical data, including patient demographics and diagnostic codes, so that important properties of the data can be extracted and adopted in cancer prediction tools, instead of having to directly access the real data itself. The team also proposes to integrate Simulacron with the Samsung Knox mobile security platform to protect the proprietary datasets and models.

Hardware/Software Co-Design to Support Heterogeneous System Security


S. Wei

As inspired and partially supported by his recent NSF CAREER award, ECE Assistant Professor **Sheng Wei** has been leading the effort of exploring heterogeneous system security problems using a hardware/software co-design method.

All about Acceleration: Heterogeneous Computing Architecture

The traditional CPU-based system can no longer meet the high speed and energy requirements of the emerging applications, such as deep learning, video processing, and scientific computing. The community has been seeking customized hardware and quantum computing as the solutions for acceleration, but in the foreseeable near future these accelerators must be deployed together with the traditional CPU in a heterogeneous system architecture.

With the ever-increasing demand of high-performance and low-energy computing, there have been two trends in accelerating the traditional CPU-based computations. One trend is to adopt customized hardware components to accelerate domain-specific computations, such as leveraging the field programmable gate arrays (FPGAs) and application specific integrated circuits (ASICs). The other emerging trend is to adopt the quantum-mechanical phenomena to achieve accelerated computations (a.k.a., quantum computing).

While significant progress has been made in both FPGA and quantum computing domains, the new computing paradigms have not been mature enough to serve as a standalone solution for deployment in empirical application scenarios, due to the following reasons. (1) Deployment Obstacle: with decades of development, there exist a large volume of traditional CPU-based applications that are challenging to be migrated to the new computing paradigms. Even if the core algorithmic components can be migrated with fine-tuned procedures, many key execution components, such as the scheduling and the user interface, would still rely on the traditional CPU. (2) Resource Obstacle: While demonstrating huge potential in accelerating computations in many fields of studies, there exists a massive gap between the demand of the physical resources (e.g., the customized hardware and the qubits) and the actual system resource availability. To overcome the two obstacles, the community has reached a consensus on the co-location of the traditional CPU component and the emerging accelerator in the same system as a near-term, deployable solution. In this case, the new computation component is often deployed as a co-processor assisting the CPU in speeding up a portion of the computations. For instance, the CPU-FPGA hybrid systems have been intensively explored and deployed as a viable solution in commercial cloud computing services, such as Amazon AWS. Similarly, quantum theorists and computer architects have proposed the hybrid computation model involving both classical and quantum computing paradigms.

The Other Side of the Coin: Heterogeneous Security Problem

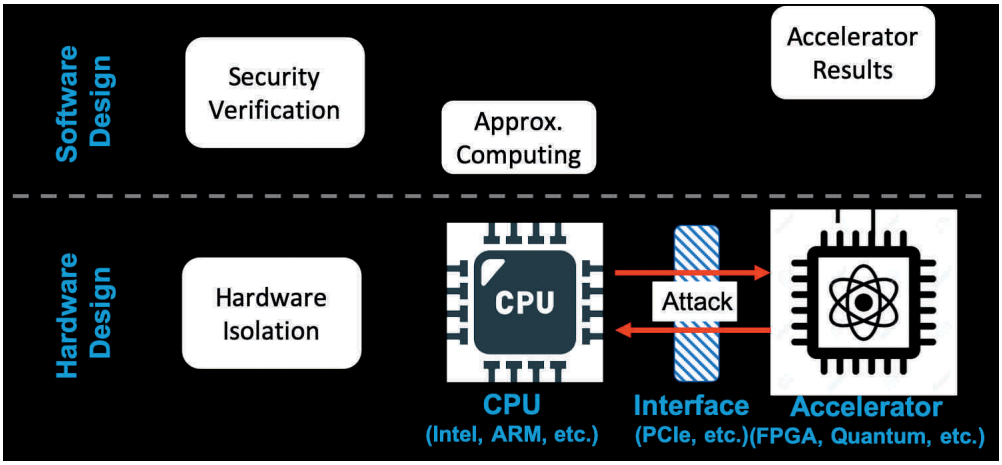
While the community have been focusing on maximizing the performance benefits of the heterogenous architecture, Dr. Wei's group identified new security concerns in these emerging system architectures and computation models.

The CPU-FPGA Security Challenge

Dr. Wei's group observes that the interplay between CPU and FPGA in the heterogeneous arechitecture introduces brand new attack surfaces through communications between these two components, including (1) CPU to FPGA attack, in which the CPU software application attempts to compromise the FPGA system, to leak confidential data or issue denial of service attacks; and (2) FPGA to CPU attack, in which the FPGA attempts to compromise the CPU software application, to interrupt its execution or compromise critical code/data. Both threat models pose significant security challenges, since they would break the container-based isolation in the traditional cloud systems.

The Classical-Quantum Security Challenge

The hybrid classical-quantum computation model has the potential of demonstrating



quantum supremacy and achieving real commercial deployments of quantum algorithms in the foreseeable near future, but it still faces significant challenges in terms of reliability due to the high and variable noises associated with the physical properties of the qubits. The reliability challenge has recently motivated the exploration of Noisy Intermediate-Scale Quantum (NISQ) in the quantum computing community, where researchers have proposed compiler-level solutions to map the logical qubits to physical qubits aiming to minimize the error rate. While the reliability challenge has been actively studied by the community, Dr. Wei's group identifies that the reliability problem can be proactively exploited by adversaries to compromise the security of the classical-quantum computation model. More importantly, such attacks with malicious intents could bypass the reliability remedies deployed in the classical world and negatively impact the quantum world without requiring the attackers having physical access or instrumentation to the quantum computer.

Hardware/Software Co-Design: Bridging the Heterogeneous Security Gap

As countermeasures, Dr. Wei's group has been developing a hardware/software co-design approach to address the emerging heterogeneous security challenges. The hardware design creates a physical fence between the heterogenous components via hardware-based isolation, while the software design serves as a security guard at the fence via software-based approximate computing.

Hardware Isolation: Building the Fence

Dr. Wei's group developed a hardware isolation-based secure architecture, namely HISA, to mitigate the identified new security challenges in heterogeneous system. In a nutshell, HISA builds a fence between the heterogenous system components by extending the CPU-based hardware isolation primitive to the accelerator component. Hardware isolation techniques, such as Intel SGX, have been developed to provide hardware-enabled "sandboxes" (i.e., enclaves), which is capable of excluding the operating system from the trusted computing base. However, these techniques cannot be directly applied to heterogeneous architectures, which leaves a huge gap in protecting user's sensitive data transmitted between the CPU and the accelerator components. To this end, Dr. Wei proposed to extend the existing CPU-based hardware isolation primitives by building a secure path from the CPU to the accelerator, leading to a new hardware isolation-based framework namely SGX-Accel. The core component of SGX-Accel is a controller between the CPU application and the accelerator to monitor the connection events and authenticate both ends of the system. Also, the controller monitors data transmission through the isolation path, and the data from unauthenticated applications will be discarded, which isolates the trusted data packets from the untrusted ones.

Software Approximation: Deploying the Security Guard

The hardware isolation framework only provides the fundamental support for creating the isolated environment without security enforcement. To provide the security guarantee, Dr. Wei's group has developed a software-based runtime security monitoring mechanism, which constantly verifies the results provided by the accelerator to capture the potential security exploits. The key insight in addressing the runtime hardware security challenge is inspired by the runtime redundancy-based verification used in fault-tolerant system design, where one or multiple repeated executions of the key algorithms or operations are conducted to approve or disapprove the potentially faulty primary execution. While the redundancy-based verification works effectively for fault-tolerant systems, there are two major challenges to apply it to the security domain. (1) security challenge: Under the security context the repeated executions must be conducted on a separate trusted component, other than the component under verification, as otherwise the repeated executions would also be contaminated with the attack and eventually result in false negatives in the security verification; and (2) performance challenge: The repeated executions may cause significant performance overhead and thus easily compromise the premium runtime performance benefit brought by the accelerator.

Dr. Wei's group addressed both challenges by developing a software-based security verification framework that employs approximate computing. In particular, the security challenge was addressed by deploying the verification process (i.e., the repeated executions) in the CPU component, which is separate from the accelerator and considered as trustworthy. Furthermore, to address the performance challenge, the team develops an approximate software version of the accelerator on the CPU for the runtime repeated executions. The key rationale behind this design is that the computation accuracy required by the repeated executions (for security verification) is orders of magnitude lower than that of the accelerator under verification. It is because a malicious security attack would typically dramatically change the results of the system, which can be effectively captured by an inaccurate but fast approximate execution.

Irons Endowed Lectureships 2019

Henry R. Irons (BS'43 and MS'47) established Henry R. and Gladys V. Irons Endowed Lectureship to provide financial assistance to the Department of Electrical and Computer Engineering for annual lectures for students, faculty and the general university community at no charge to the participants. Speakers present on technical topics in the areas of electrical/wireless communications, computer hardware/software engineering, digital signal processing, systems and electronic controls, and solid state electronics.

For 2018-2019, three lectures were supported by the Irons Endowed Lectureship:

March 8, 2019
Speaker:
Mary 'Missy' Cummings,
Duke University
Title: A Machine Learning Approach to Modeling Human Interaction with Autonomous Systems

March 27, 2019
Speaker: Mehmet Toner,
Harvard Medical School
Title: Extreme Microfluidics - Label Free Sorting of Extremely Rare Circulating Tumor Cells and Clusters

April 17, 2019
Speaker: Maysam Chamanzar, CMU
Title: From Flexible Implants to Virtual Acousto-optic Neural Interfaces

Collaborative: Reliable Underwater Acoustic Video Transmission Towards Human-robot Dynamic Interaction

D. Pompili

Professors **Dario Pompili** (ECE) and **Javier Diez** (MAE) received an NSF research grant for the project titled "Reliable Underwater Acoustic Video Transmission Towards Human-Robot Dynamic Interaction." This is a three-year $1M collaborative effort led by Rutgers University (Dario Pompili, PI) with Northeastern University.

In the past decade, underwater communications have enabled a wide range of applications; there are, however, novel underwater monitoring applications and systems based on human-robot dynamic interaction that require real-time multimedia acquisition and classification. Remotely Operated Vehicles (ROVs) are key instruments to support such interactive applications as they can capture multimedia data from places where humans cannot easily/safely go; however, underwater vehicles are often tethered to the supporting ship by a cable or have to rise periodically to the surface to communicate with a remote station via Radio Frequency (RF) waves, which constrains the mission in terms of number of robots that can be involved in them mission, application execution time, and operating range. Wireless acoustic communication is the typical physical-layer technology for underwater communication; however, video transmissions via acoustic waves are hard to accomplish as the acoustic waves suffer from attenuation, limited bandwidth, Doppler spreading, high propagation delay, high bit error rate, and time-varying channel. For these reasons, state-of-the-art acoustic communication solutions are still mostly focusing on enabling delay-tolerant, low-bandwidth/low-data-rate s calar data transmission or at best low-quality/low-resolution multimedia streaming in the order of few tens of Kbps.

Examples of novel underwater monitoring applications based on human-robot dynamic interaction are: coastal/tactical multimedia surveillance, undersea/offshore exploration, oil pipe/bridge inspection, video monitoring of geological/biological processes from seafloor to air-sea interface, real-time multimedia acquisition/classification, just to name a few. Fig. 1 shows the schematics of an application where bridge pillars are safely inspected using an heterogenous team of semi-autonomous robots such as the underwater BlueROV [1] and the Rutgers Naviator, a versatile multi-medium quadcopter developed in Dr. Diez's lab that is able to fly like a drone and swim like a submarine

The objectives of this collaborative research program are: (1) To design novel Multiple Input Multiple Output (MIMO)-based communication solutions for robust, reliable, and high-data rate underwater multimedia streaming in the order of hundreds of Kbps; (2) To investigate the problem of integrating communication methods available in multiple environments on an innovative software-defined testbed architecture integrating miniaturized MEMS-based Acoustic Vector Sensors (AVSs) [2] that will enable processing-intensive physical-layer functionalities as software-defined, but executed in hardware that can be reconfigured in real time by the user based on the Quality of Experience (QoE).

Specifically, the Rutgers Cyber-Physical Systems Laboratory (CPS Lab), led by Dr. Pompili, is developing a software-defined MIMO acoustic testbed for video streaming, which is aimed at (i) studying the distortion-rate and diversity-multiplexing tradeoffs (as shown in the schematics of Fig. 2), (ii) enhancing reconfigurability on real-time Ettus X-300/X-310 FPGA-based Universal Software Radio Peripheral (USRP) [4] with high processing capabilities (as shown in Figure 3), and (iii) implementing video layering composed of a base layer plus one or more enhancement layers (via different modalities in time, space, and quality). Fig. 3 shows (a) the high performance and scalable software-defined radio boards that are used as the main processor in the testbed; (b) an underwater acoustic hydrophone used in this project to transmit/receive underwater acoustic waves; and (c) custom-designed power amplifiers to increase the range of acoustic underwater communications from few meters to hundreds of meters.

This project has a strong multidisciplinary component that involves a nexus of ideas from sensor technology, communications, networking, algorithms, statistical inference, and dynamical systems. Our methods and algorithms will have a wide applicability in areas of science and technology that concern (1) real-time multimedia transmission of coordinated robots and (2) the study of dynamic interaction of such robots with their environment and the humans. Our work will also result in a unique generation of undergraduate and graduate researchers with a comprehensive knowledge of communication, computational, and mechanical engineering with application to marine and environmental sciences, and will also impact other disciplines (e.g., physical sciences and humanities).

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[1] Blue Robotics, [Online]. Available: http://www.bluerobotics.com.

[2] M. Rahmati and D. Pompili, "SSFB: Signal-space-frequency beamforming for underwater acoustic video transmission," in Proc. of the IEEE Mobile Ad Hoc and Sensor Systems (MASS) Conference, 2017, pp 180–188 (Best Paper Award).

[3] M. Rahmati, A. Gurney, and D. Pompili, "Adaptive underwater video transmission via software-defined MIMO acoustic modems," in Proc. of the IEEE/MTS OCEANS Conference, 2018, pp 1–7.

[4] Ettus Research, [Online]. Available: https://www.ettus.com

[5] Teledyne Marine, [Online]. Available: http://www.teledynemarine.com

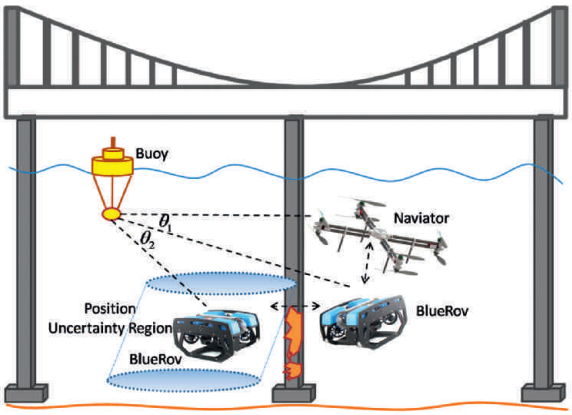


Figure 1: Schematics of bridge pillars inspection with a team of semi-autonomous robots.

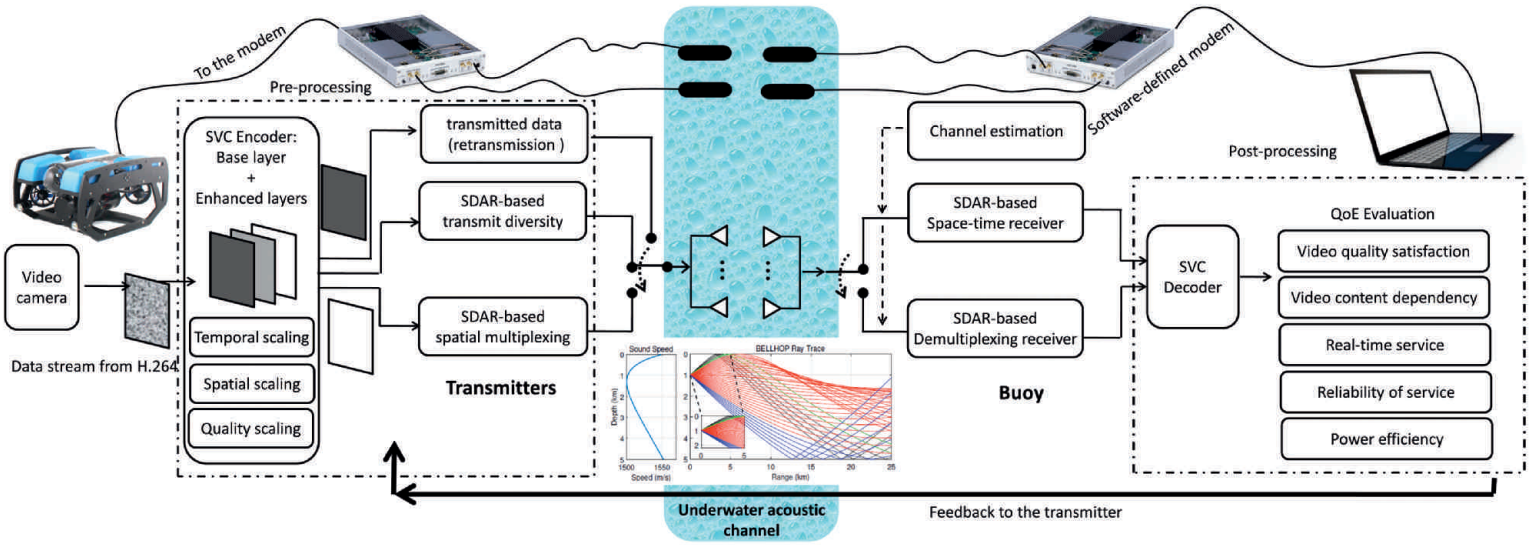


Figure 2: Multiple Input Multiple Output (MIMO)-based acoustic testbed for video stremaming [3].

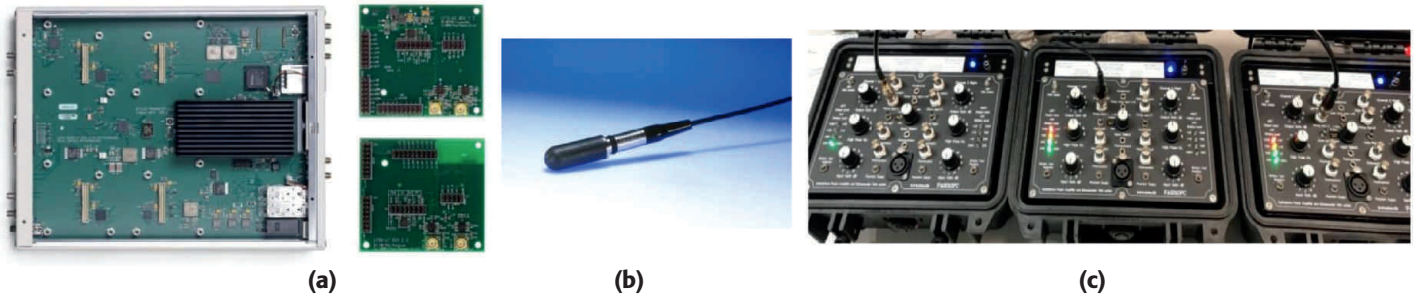
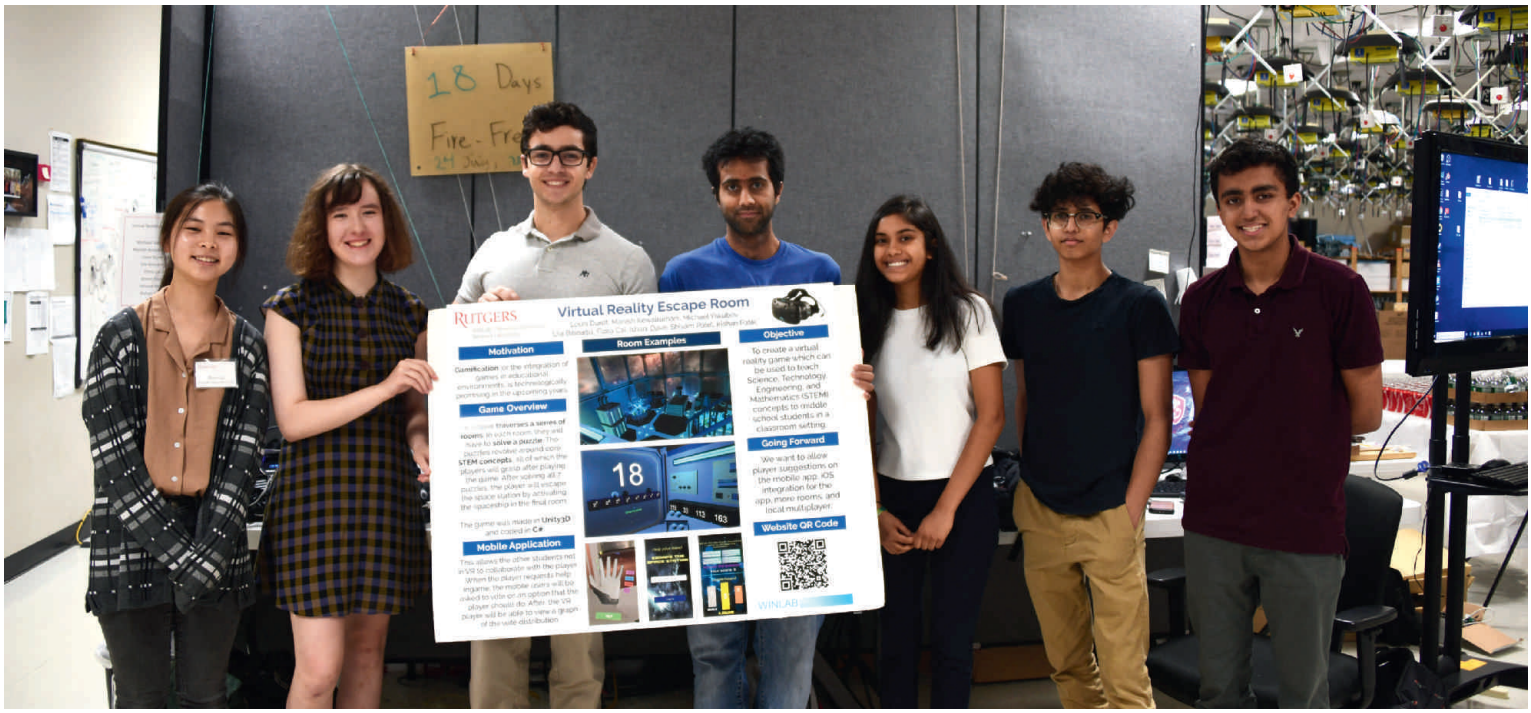


Figure 3: Software-defined testbed components for underwaert acoustic video streaming; (a) FPGA-based Universal Software Radio Peripheral (USRP) boards [4]; (b) Underwater acoustic transducer [5]; and (c) Custom-designed power amplifiers to increase the underwaetr acoustic communication range from few meters to hundreds of meters.

WINLAB Summer Research Program



This summer, 56 students (20 high school, 31 undergraduate, and 5 graduate) gathered together to take part in WINLAB's annual Summer Research Program, where they had the opportunity to learn from staff and peers about the challenges and rewards of research and development for networking technology and related fields.

One such student, undergraduate Michael Yakubov, says this of his time: "My summer internship at WINLAB was an amazing experience. In my previous projects and internships, I usually worked alone or with a single partner, but at WINLAB I had the opportunity to work with an amazing group of undergraduate and high school interns, all of whom were incredibly nice and wonderful to work with."

"This experience has allowed me to use the knowledge I know from what I have learned from class and apply it," says Ishani Dave, a fellow undergraduate, "Even though learning a new language and adjusting to the software was challenging, it was a good learning experience for me."

Both these students collaborated on one of the largest teams this year, in order to help design and build a Virtual Reality Escape Room, the results of which were showcased at the annual WINLAB Summer Internship Open House on August 15th.

"Interning at WINLAB Rutgers has been a series of broken expectations, but all for the better. Entering the program as a high school student with little to no collaborative work experience, my expectations of an intimidating, strict environment were cut as I got to work with various friendly peers," reflects Ula Bitinaitis, "We hit the ground running when learning various programs and languages from scratch, but with the guidance of the undergraduates in our group, as well as an incredibly warm work environment, the experience was as equally fun as it was challenging. We hit nearly all of our goals when developing our virtual reality escape room, and we're optimistic that it will aid struggling children in an academic setting."

Outside the realm of virtual reality, last year's scale model of a real New York city intersection saw an expansion of scope and scale by the interns, featuring in projects that explored the problems of localization (Smart Monitoring of Environmental Dynamics Using Smart Cars and Drones), building models for automated driving (Smart Intersection Traffic Modeling, and Self Driving Vehicular Environment), as well as the study traffic patterns themselves (Deep Learning Methods for Traffic Data Classification).

Students did not limit their days researching the theoretical outdoors. Joseph Florentine, a returning summer intern at the lab, took his research in a different direction than previously: "This summer in particular, along with more technical experience, I also gained leadership experience helping lead a research investigation on the possible effects of RF on honey bees." This research group found themselves making the trek to and from the lab and field for their studies, contending with trials of monitoring the bees and waterproofing research equipment. "During these 7 weeks, I became way more comfortable around honey bees," recounts Justin Yu, "In addition, I expanded my previous know-how of linux systems and automation and also vastly increased my knowledge on a new programming language, python. Also, I met a lot of cool people that I will certainly keep in touch with even after the internship is over."

Justin is not alone in expressing that sentiment; a number of students have commented on the fun, interdisciplinary work they accomplished this year, as well as a wish to do more. Perhaps next summer will see the return of those same students, as well as new ideas to expand on old projects, or to explore new directions. Says Flora Cai, "This summer internship was a great experience. I was given tools and technology similar to those used in proper companies. The group aspect of the project allowed me to gain real life experience working with colleagues. I would be more than glad to work here next summer."

WINLAB/ECE team wins Juniper SDN competition

Sumit Maheshwari, Aayush Shah, Mohit Sheth.

A WINLAB/ECE team led by doctoral student **Sumit Maheshwari** along with master's students **Aayush Shah** and **Mohit Sheth** won first place at the recent Juniper Network and Comcast SDN Throwdown competition. The challenge involved implementing a software defined network (SDN) controller that maximizes flow throughput in a disrupted network scenario.

At the start of the competition eight teams participated with the finalists convening at the Juniper OpenLab in Bridgewater. Among the finalists--Rutgers, Columbia, NYU, Santa Clara, and UC Boulder--Rutgers prevailed deveoloping a system they call "NOVA: Network Optimization via Automation." NOVA addresses network congestion and failures by enabling the system to choose the best available network path based upon network statistics and reliability.

According to Maheshwari, the impact of external factors such as earthquakes, Tsunami, and other disruptors can be analyzed to optimize the network, by obtaining real-time and historical data using SDN.

"If there is physical fiber link passing through the flood-prone zone and we have the reliability statistics of that link from the historical data, while assigning the path, we can weigh that link a little lower and thereby avoid the Shared Link Risk Groups (SLRG) probability," he says.

The winning team received an opportunity to donate $5,000 on behalf of Rutgers to a STEM focused non-profit organization.

"We chose Verizon foundation for the donation as it is focused on improving the in-school technical programs including access to 5G and supports urban as well as rural communities by exposing students to the skill-building activities such advanced networking, machine learning and Augmented Reality (AR)," says Maheshwari.

Ivan Seskar appointed Chief Technologist, WINLAB

Rutgers University has approved the promotion of **Ivan Seskar** to the newly created position of Chief Technologist, WINLAB effective 9/24/2018. As Chief Technologist, Ivan will be responsible for leading WINLAB's technology R&D programs including major new projects such as COSMOS, handling industry/standards outreach and international collaborations, and managing WINLAB's research/IT infrastructure.

Please join us in congratulating Ivan on this well-deserved promotion, and thanking him for over 25 years of sustained contributions to WINLAB's and ECE's excellence at Rutgers!


I. Seskar

faculty news

Saman Zonouz Wins 2019 PECASE Award

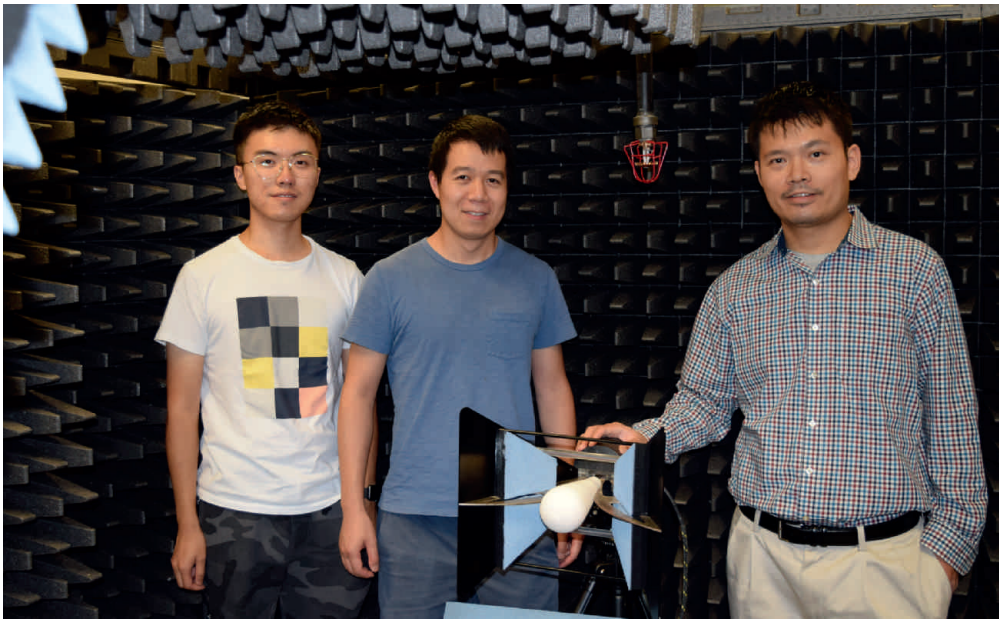
ECE Associate Professor **Saman Zonouz** has been awarded the 2019 Presidential Early Career Award for Scientists and Engineers (PECASE) Award. The PECASE is the highest honor bestowed by the United States Government to outstanding scientists and engineers who are beginning their independent research careers and who show exceptional promise for leadership in science and technology. Established in 1996, the PECASE acknowledges the contributions scientists and engineers have made to the advancement of science, technology, engineering, and mathematics (STEM) education and to community service as demonstrated by scientific leadership, public education, and community outreach. The White House Office of Science and Technology Policy coordinates the PECASE with participating departments and agencies.

Saman was recognized at a ceremony at the White House on July 25 for his research related to his NSF CAREER Award on the project "Trustworthy and Adaptive Intrusion Tolerance Capabilities in Cyber-Physical Critical Infrastructures." In this project Saman will design secure mechanisms for cyber-physical critical infrastructures that integrate networks of computational and physical processes to provide the society with essential services. The power grid, in particular, is a vast and interconnected cyber-physical network for delivering electricity from generation plants to end-point consumers.

Protecting power grid critical infrastructures is a vital necessity because the failure of these systems would have a debilitating impact on economic security and public health and safety. However, several recent large-scale outages and the significant increase in the number of major attacks over the past four years confirm the insufficiency of the current protection solutions for these systems. Existing tedious manual tolerance procedures cannot protect those grids against sophisticated attacks. Additionally, the use of purely-cyber security solutions for power grid resiliency is not sufficient because they ignore the cyber-physical interdependencies, power-side sensor measurements, and the possibility of countermeasures in power infrastructures.

The objective of this research is to investigate fundamental problems in cyber-physical tolerance and develop an integrated set of mathematically rigorous and real-world deployable capabilities, resulting in a system that can model, analyze, predict, and tolerate complex security incidents in computing, physical, or communication assets in a near-real-time manner. The proposed research will provide system administrators and power grid operators with scalable and online integrated cyber-physical monitoring and incident response capabilities through keeping track of cyber-physical infrastructures' dynamic evolution caused by distributed security incidents, optimal proactive response and recovery countermeasures and adaptive preparation for potential future security incidents.

Michael Wu Wins DARPA Young Faculty Award



ECE Assistant Professor **Chung-Tse Michael Wu** has received the DARPA Young Faculty Award (YFA) for the project titled "Metamaterial Integrated Ultra-Broadband Antenna Array with Embedded Reconfigurable Non-Foster Circuits." The objective of the DARPA YFA program is to identify and engage rising stars in junior research positions, and expose them to DoD needs and DARPA's program development process. The YFA program provides funding, mentoring and industry and DoD contacts to awardees early in their careers so they may develop their research ideas in the context of national security needs. The long term goal of the YFA program is to develop the next generation of academic scientists, engineers, and mathematicians who will focus a significant portion of their career on DoD and National Security issues. Michael has also been recognized previously with a NSF CAREER Award. This most recent award is the 9th award by a young investigator in the ECE department (along with 8 active NSF CAREER Awards), reflecting the phenomenal successes of our young faculty members!

Michael and his group will create an ultra-broadband antenna array that aims to provide 1-100 GHz instantaneous bandwidth, fundamentally enabled by an innovative integration of metamaterial (MTM) antenna elements, metasurfaces and a novel type of reconfigurable negative group delay (NGD)-based non-Foster circuits.

Mehdi Javanmard awarded NSF Career Award

M. Javanmard

ECE Associate Professor **Mehdi Javanmard** awarded NSF CAREER for the project titled "CAREER: Reconfigurable Electro-Fluidic Prescriptions (REFRx): Data-Driven Biosensors for Detection and Treatment of Multidrug-Resistant Cancers." This is a five-year $500,000 award. These prestigious awards are in support of early-career faculty who have the potential to serve as academic role models in research and education and to lead advances in the mission of their department or organization. This most recent CAREER award makes it the 8th active CAREER Award in the ECE department, reflecting the phenomenal success of our young faculty members!

Mehdi and his group will develop an instrument that can rapidly identify drug resistant cancer cells in tumors and prescribe a course of treatment for the patient that minimizes chance of cancer recurrence. Drug resistance is one of the greatest impediments to treating both cancer and infectious disease and has been identified as one of the greatest public health threats of the next several decades. The proposed miniaturized instrument can be utilized for rapidly screening cancer patients for drug resistance and identifying the key molecular players involved and selecting optimal cancer treatment drugs. In this work, a microfluidics/electronic/data-driven crosscut approach is proposed to enable a rapid technology that can identify drug resistant cells using machine learning and examine the key protein pathways resulting in resistance using a label-free sensing array. The proposed platform is adaptive and reconfigures itself to assay the relevant proteins on-demand and avoids a resource-hungry brute force approach. This interdisciplinary project will engage and train both graduate and undergraduate students in various areas and also K-12 students through outreach workshops, local industry through educational lectures, and the general public through development of an online course, resulting in broad dissemination of knowledge.

Athina Petropulu Named a Fellow of AAAS and Distinguished Lecturer of the IEEE Aerospace & Electronic Systems Society (AESS)


A. Petropulu

Distinguished Professor **Athina Petropulu** has been named a fellow of the American Association for the Advancement of Science (AAAS). In a tradition stretching back to 1874, the AAAS recognizes fellows for their extraordinary achievements in research and the advancement of science. New Fellows are honored at an event at the AAAS Annual Meeting the following February where they receive a certificate and rosette. The names of the newly elected Fellows are also published in the journal "Science".

With growing consumer demand for wireless technologies, significant investments have been made in commercial wireless networks. The viability of these investments depends on overcoming the challenges introduced by the broadcast nature of the wireless medium, such as interference, fading and eavesdropping. Prof. Petropulu and her students developed novel signaling schemes that use the concept of network node cooperation to overcome these challenges and achieve high quality, secure wireless communications. Her highly cited work on physical layer security exploits the physical characteristics of the wireless medium to prevent eavesdropping without requiring encryption. She also introduced novel radar systems that rely on advanced signal processing techniques to match the resolution of state-of-art radar while requiring significantly fewer measurements, thus enabling faster target tracking and detection.

The association cited Dr. Petropulu for "distinguished contributions to the field of signal processing with applications to wireless communications and networking, physical layer security and radar signal processing".

Distinguished Professor Athina Petropulu was also named Distinguished Lecturer of the IEEE Aerospace & Electronics Systems Society (AESS). The IEEE Distinguished Lecturers are engineering professionals who help lead their fields in new technical developments that shape the global community. These experts specialize in the field of interest of their society and travel to various technical and regional groups, such as Society and Technical Council Chapters, to lecture at events. Prof. Petropulu delivered a lecture related to her radar research, in particular on "Optimum Co-Design for Spectrum Sharing Between MIMO Radar and MIMO Communication Systems," "Radar Privacy in Shared Spectrum Scenarios," and "Multidimensional Sparse Fourier Transform and Application to Digital Beamforming Automotive Radar."

Grigore Burdea receives 2018 Most Impactful Rehab Tech Award


G. Burdea

Professor **Grigore Burdea** is the recipient of the American Congress of Rehabilitation Medicine's 2018 Most Impactful Rehab Tech Award. The American Congress of Rehabilitation Medicine is the largest conference in the world on research in rehabilitation.

The award is in recognition of Professor Burdea's work on 21st Century integrative medicine. Professor Burdea is known for his use of therapeutic games to treat the patient from a holistic approach. Most notably, the benefits of Professor Burdea's research have been demonstrated in a male dementia patient regaining his ability to read within three-weeks of therapy and a fifteen year old stroke patient improving his daily activities completion rate by 30% after a month of therapy. Bright Cloud International, a Rutgers startup, is rooted in decades of research Professor Burdea has conducted at the Rutgers CAIP Center and the Tele-Rehabilitation Institute.

Professor Grigore Burdea is the lead author of the paper titled "Novel Therapeutic Game Controller for Telerehabilitation of Spastic Hands: Two Case Studies" that has won the best paper award at the 13th International Conference on Virtual Rehabilitation (ICVR) that was held in Tel Aviv, Israel in July 2019. The goal of the ICVR conference series is to provide an overview of applied and clinical research on technologies in the field of virtual rehabilitation. In this paper, Professor Burdea and his coauthors design a novel BrightBrainer Grasp (BBG) controller that can overcome challenges faced in post-stroke rehabilitation due to hand spasticity. The custom controller measures power grasp, finger extension, wrist position and orientation, as well as 3D hand position. It is designed to minimize friction when used by those with no gravity bearing. The paper presents a detailed description of the BBG controllers and their interaction with the BrightBrainer™ gaming system, including two successful case studies.

Grigore Burdea wins Best Paper Award at the 2019 International Conference on Virtual Rehabilitation

Professor **Grigore Burdea** is the lead author of the paper titled "Novel Therapeutic Game Controller for Telerehabilitation of Spastic Hands: Two Case Studies" that has won the best paper award at the 13th International Conference on Virtual Rehabilitation (ICVR) that was held in Tel Aviv, Israel in July 2019. The goal of the ICVR conference series is to provide an overview of applied and clinical research on technologies in the field of virtual rehabilitation. In this paper, Professor Burdea and his coauthors design a novel BrightBrainer Grasp (BBG) controller that can overcome challenges faced in post-stroke rehabilitation due to hand spasticity. The custom controller measures power grasp, finger extension, wrist position and orientation, as well as 3D hand position. It is designed to minimize friction when used by those with no gravity bearing. The paper presents a detailed description of the BBG controllers and their interaction with the BrightBrainer™ gaming system, including two successful case studies.

Athina Petropulu, Distinguished Professor of ECE was elected President-Elect for the IEEE Signal Processing Society for the term 1 January 2020 through 31 December 2021.

This is the first time that the IEEE Signal Processing Society President-Elect was elected directly by the membership.

Founded as IEEE's first society in 1948, the Signal Processing Society (SPS) is the world's premier association for signal processing engineers and industry professionals. Its history spans almost 70 years, featuring a membership base of more than 19,000 signal processing engineers, academics, industry professionals and students spanning 100 countries worldwide. The Society organizes numerous conferences around the world every year, focusing on the innovations shaping the future of signal processing and the future of our world.

Signal processing (SP) is the brain of most technologies that have changed the course of history, e.g., the wireless phone, radars, virtual reality, robotics, video streaming, just to name a few. It is in the core of tools that have revolutionized our understanding of the world, such as data analytics, data modeling, machine learning. It is the key enabler in the emerging areas of smart and sustainable cities, biologically inspired systems, e-health, cybersecurity, quantum and other new forms of computing, self-driving vehicles, and advanced manufacturing. While all already in signal processing are well aware of the role SP has played and continues to play, the general public cannot easily relate to SP.

Athina Petropulu campaigned on building a mindshare of Signal Processing as the innovation engine of Science and Engineering and on expanding the talent pool interested in SP, while promoting quality and inclusion.

Janne Lindqvist's Work Featured on PBS SciTech

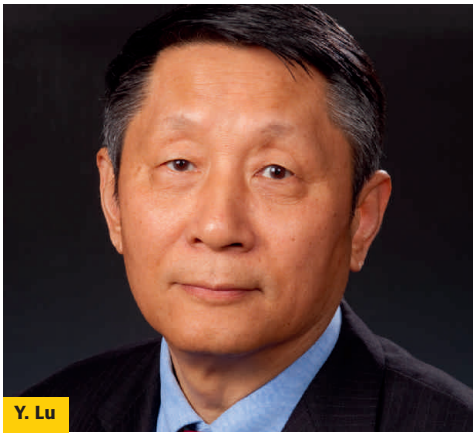
Associate Professor **Janne Lindqvist**'s research on mobile authentication was recently featured on the PBS SciTech Now program. Janne Lindqvist joins TV host Hari Sreenivasan to discuss this new method of password security that uses squiggly lines instead of traditional passwords.

The interview can be watched at https://www.pbs.org/video/janne-lindqvist-vfbozw/

Computational Agriculture Research

ECE Professor **Kristin Dana** has collaborated with Prof. Peter Oudermans (Rutgers University) and Dr. Aditi Roy (Siemens Corporation) and received a USDA research grant as part of the AFRI FACT (Food and Agriculture Cyberinformatics and Tools) Initiative. The grant entitled "Deep Learning for Image-based Agriculture Evaluation" is a three year $500,000 research program to leverage recent advances in computer vision and AI to explore exciting new opportunities for applications in computational agriculture. The interdisciplinary team will create new, paradigm-shifting approaches for quantitatively evaluating plant health using drone imagery data. The work will focus on cranberry crops at Philip E. Marucci Blueberry and Cranberry Research and Extension Center at Rutgers University. The long term goal is to enable and support real time crop assessment to facilitate management and to optimize crop yields. This project is a public and private partnership integrating multi-disciplinary research at Rutgers University and research at Siemens Corporation. This partnership will address critical data needs in agriculture by leveraging expertise in two main areas: 1) computer vision and deep learning: for the development of computational algorithms for acquiring, characterizing and analyzing visual patterns in large image datasets; 2) plant biology and field research to connect and implement the algorithms. The research focuses on two of the FACT priorities: analysis and technologies. In particular, for analysis we propose data-integration tools to combine multiscale, multispectral, and time-sequence imagery in order to determine the cranberry crop properties such as cranberry condition using classification of albedo variation, cranberry count using high-accuracy segmentation via machine learning, cranberry temperature estimation using both sensors and infrared imaging. New algorithms will be developed for cranberry segmentation, temporal albedo classification for cranberry health evaluation and sky cloud cover classification. These algorithms will be combined to predict cranberry crop yield based on efficient drone-sampling that can eventually be used for irrigation planning and additional agricultural planning strategies.

Yicheng Lu named 2019 School of Engineering Faculty of the Year


Y. Lu

Dean Thomas Farris has just announced that Distinguished Professor **Yicheng Lu** will receive the 2019 School of Engineering (SoE) Faculty of the Year Award. This award recognizes exceptional contributions of a SoE faculty member to the School of Engineering, the University, the engineering profession, the scientific community and/or society at large. Yicheng was recognized with this award at a SoE Faculty Recognition Event on September 19 at 4 pm in Richard Weeks Hall of Engineering, where he will receive a plaque and a monetary award in the amount of $5,000 to be used to support his continued research and scholarship activities.

Salim El Rouayheb selected for the A. Walter Tyson Assistant Professorship Award


S. El-Rouayheb

Dean Tom Farris of the School of Engineering has announced that Assistant Professor **Salim El Rouayheb** has been selected for the A. Walter Tyson Assistant Professorship Award. The Tyson fund, established by A. Walter Tyson, a 1952 alumnus of the School, is used to recruit promising junior faculty. Funds made available through the generosity of the Tyson Family are used to offset the School's investments in talented young faculty. With this award, funds will be used toward the School commitments that were made toward Professor El Rouayheb's start-up package.

Salim was publicly recognized at the SOE Faculty Recognition Event on September 19, 2019

Janne Lindqvist Promoted to Associate Professor with Tenure

The Board of Governors has approved Dr. **Janne Lindqvist**'s promotion to Associate Professor with tenure effective July 1, 2019. Congratulations on this well deserved accomplishment Janne!

Waheed Bajwa voted 2019 EGC Professor of the Year in ECE


W. Bajwa

Waheed Bajwa, an Associate Professor in the ECE department, has been voted by the Rutgers SOE Undergraduate Student Body to receive the 2019 Engineering Governing Council (EGC) Professor of the Year Award from within the Department of ECE. This award is annually given to one faculty member from each department in Rutgers SOE who best exemplifies the SOE mission of "Education, Research, and Service." This is Dr. Bajwa's third time receiving this award since he joined Rutgers SOE in 2011. During these eight years, in addition to teaching various graduate-level courses, he has regularly taught undergraduate digital signal processing to electrical engineering majors (juniors and seniors). He is currently in the process of developing a machine learning class for the entire SOE undergraduate student body, with the first offering in Fall 2018 and the second offering in Fall 2019.

Mehdi Javanmard Promoted to Associate Professor with Tenure

The Board of Governors has approved Dr. **Mehdi Javanmard**'s promotion to Associate Professor with tenure effective July 1, 2019. Congratulations on this well deserved accomplishment Mehdi!

Prof. Javanmard's Research Featured on PBS

Prof. Mehdi Javanmard's wearable biosensing work was featured on PBS. Please enjoy the video at: https://www.pbs.org/video/hill-smart-wristbands-1533913183/

newgrants

Waheed Bajwa
National Science Foundation (NSF) award for the project entitled "Distributed Machine Learning in the Age of Fast Data Streams." This is a three-year $450,000 project.

Yingying Chen
National Science Foundation (NSF) award for the project titled " Security Assurance in Short Range Communication with Wireless Channel Obfuscation." This is a one year project of $170,000 in collaboration with Indiana University. The Rutgers share is $85,000.

Yingying Chen
National Science Foundation (NSF) award for the project titled "Software Hardware Architecture Co-design for Low-power Heterogeneous Edge Devices" This is a three-year project of $500,000 in collaboration with Binghamton University. The Rutgers share of the award is $320,000.

Kristin Dana
Lockheed Martin grant for the project "Multiscale Deep Learning For Temporal Patterns." This is a one-year award for $120,183.

Kristin Dana
3 year grant from the USDA-NIFA Food and Agriculture Cyberinformatics and Tools (FACT) Initiative entitled "FACT: Deep Learning for Image-based Agriculture Evaluation". The award amount is $499,989.

Umer Hassan (PI) and
Mehdi Javanmard (a co-PI)
Busch Biomedical Grant of $40,000 from the Office of the Vice Chancellor for Research and Innovation, Rutgers-New Brunswick.

Mehdi Javanmard (a co-PI)
NSF MRI grant for the project "Acquisition of a High Resolution X-ray Computed Tomography Instrument for a Multi-User Imaging Facility." This $399,969 award will enable acquisition of a high-resolution scanner that can obtain detailed 3D images at the micron or sub-micron level of a broad range of samples (ranging from biological specimens to biomaterials to 3D printed objects to soil samples) without destroying or altering the sample.

Mehdi Javanmard
2019 National Science Foundation (NSF) Faculty Early Career Development (CAREER) Award titled "Reconfigurable Electro-Fluidic Prescriptions (RE-FRx): Data-Driven Biosensors for Detection and Treatment of Multidrug-Resistant Cancers." This is a 5-year award for $400,426.

Ivan Marsic
National Science Foundation (NSF) award for the project titled "Activity Recognition for Reducing Delays in Fast-Response Teamwork." This is a four-year $1.2M collaborative effort led by Rutgers University (Ivan Marsic, PI) with Drexel University and Children's National Medical Center in Washington, DC. Rutgers' share of this award is $700,000.

Laleh Najafizadeh
EAGER National Science Foundation (NSF) award for the project "Adapting Multi-Modal BCI-Based Assistive Technologies for Patients with High Spinal Cord Injury." This is a 1 year $120,000 award from the NSF.

Dario Pompili
NSF award for the project titled "Real-Time Autonomic Decision Making on Sparsity-Aware Accelerated Hardware via Online Machine Learning and Approximation." This three-year $1.4M project includes Associate Professor Saman Zonouz and Assistant Professor Bo Yuan as co-PIs.

Anand Sarwate
National Science Foundation (NSF) award for the project titled "Between Shannon and Hamming." This is a three-year $500,000 collaborative award led by Rutgers (Anand Sarwate, PI) with the University at Buffalo (Michael Langberg, co-PI). Rutgers' share of this award is $250,000.

Anand Sarwate (PI) and **Waheed Bajwa (a co-PI)** are the recipients of a new National Science Foundation (NSF) award for the project titled "ESTRELLA: Exploiting Structure in Tensors for Representation, Estimation, and Limits of Learning Algorithms." This is a three-year $499,976 award.

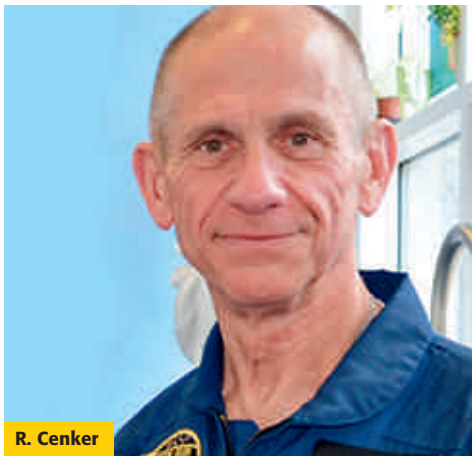
Sheng Wei
National Science Foundation (NSF) award for the project "Content-Based Viewport Prediction Framework for Live Virtual Reality Streaming." This is a three-year $496,085 collaborative award led by Rutgers with Northeastern University and Texas State University. Rutgers' share of this award is $214,874.

Chung-Tse Michael Wu
DARPA Young Faculty Award (YFA) for the project titled "Metamaterial Integrated Ultra-Broadband Antenna Array with Embedded Reconfigurable Non-Foster Circuits." This is a 2-year award for $500,000.

Saman Zonouz (PI) and
Mehdi Javanmard (co-PI)
National Science Foundation (NSF) award for the project titled "Srch3D: Efficient 3D Model Search via Online Manufacturing-specific Object Recognition and Automated Deep Learning-Based Design Classification." This is a three-year $1.2M collaborative award led by Rutgers with Georgia Tech. Rutgers' share of this award is $600,000.

alumninews

Rutgers Electrical Engineering Alumnus Shares his Journey into Space



R. Cenker

In honor of the 50th anniversary of a man landing on the moon, the NJ Space Grant Consortium and SoE Undergraduate Education – Office of Student Services, hosted Bob Cenker, Rutgers electrical engineering alumnus and former astronaut to speak about his career at NASA and stories about his space flight.

Robert J. Cenker, a Rutgers-New Brunswick electrical engineering alumnus, was a crew member on the 1986 space shuttle Columbia, where he changed the face of cable TV across the United States. During his six-day mission, which began Jan. 12, 1986, he observed the deployment of an RCA satellite and conducted an experiment on an infrared imaging camera. In total, Cenker traveled more than 2.1 million miles in 96 Earth orbits and logged more than 146 hours in space. The mission was the final flight before the Challenger disaster, which killed seven crewmembers, including teacher Christa McAuliffe, who trained with him. As a result, Cenker's Columbia mission was called "the end of innocence" for the Shuttle program.

In celebration of the 50th anniversary of the Apollo 11 moon landing, Cenker joined students from the New Jersey Governor's School of Engineering and Technology, TARGET and EOF on July 19 to discuss his journey into space and offer a glimpse of what it takes to become an astronaut. He described how the political climate has changed since Neil Armstrong set f oot on the moon in 1969 and how the country needs to band together to return to the moon – and perhaps reach Mars.

Joe Rambala joins ECE Industrial Advisory Board

Joe Rambala is president of electronic warfare for L3Harris Technologies' Space & Airborne Systems segment. Space & Airborne Systems covers an extensive portfolio of solutions in intelligence, surveillance, small satellites, electronic warfare, avionics including carriage and release systems), wireless solutions and C4I systems. Previously, Rambala served as vice president and general manager of electronic warfare for Harris Corporation's Electronic Systems segment, prior to the company's merger with L3 Technologies, Inc. in June 2019.

Rambala is responsible for leading a portfolio of electronic warfare and radar systems across the airborne, maritime, and ground domains. He reports to the president, Space & Airborne Systems. Prior to this role, Rambala served as vice president and general manager, Precision Navigation and Timing (PNT) for Harris Corporation's Space and Intelligence Systems segment and led the Global Positioning System (GPS) Block III and Operational Control Segment (OCX) programs.

He was previously vice president and general manager of the Exelis Electronic Systems Integrated Electronic Warfare Systems business.

Rambala brings more than 30 years of program management and engineering experience in the defense and aerospace industry, and he has worked with various aerospace and defense companies, including Honeywell and AlliedSignal.

Rambala holds a Bachelor of Science in electrical engineering from the College of Engineering at Rutgers University; a Master of Science in control systems from New Jersey Institute of Technology; and an executive MBA in technology management from Stevens Institute of Technology. In addition, Rambala is certified in Value-Based Six Sigma analysis.

J. Rambala

L3Harris Technologies is an agile global aerospace and defense technology innovator, delivering end-to-end solutions that meet customers' mission-critical needs. The company provides advanced defense and commercial technologies across air, land, sea, space and cyber domains. L3Harris has approximately $17 billion in annual revenue and 50,000 employees, with customers in 130 countries.

A Wengrowski Family Tradition

Graduation Day 2019 was a big event for a local family with longstanding RU ties. **Eric Wengrowski** received his PhD in Electrical and Computer Engineering and was awarded an ECE Academic Achievement Award. Eric's sister, **Sara Wengrowski,** received a Master's Degree in Civil and Environmental Engineering. Both Eric and Sara also received their undergraduate degrees from Rutgers University. In fact, all six family members shown (see photo) are Rutgers University alum.

industryadvisoryboard

The **Advisory Board** provides input on academics, research, administration, outreach, advocacy, and development. The Board reviews the graduate and undergraduate curriculum and degree programs, program educational objectives, and program outcomes, and offers suggestions for change to keep them current. The Board evaluates the quality and scope of our research, its relationship to our programs, its relevancy and helps guide future directions. The Board recommends ways to build new relationships with industry and to strengthen those we have.

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