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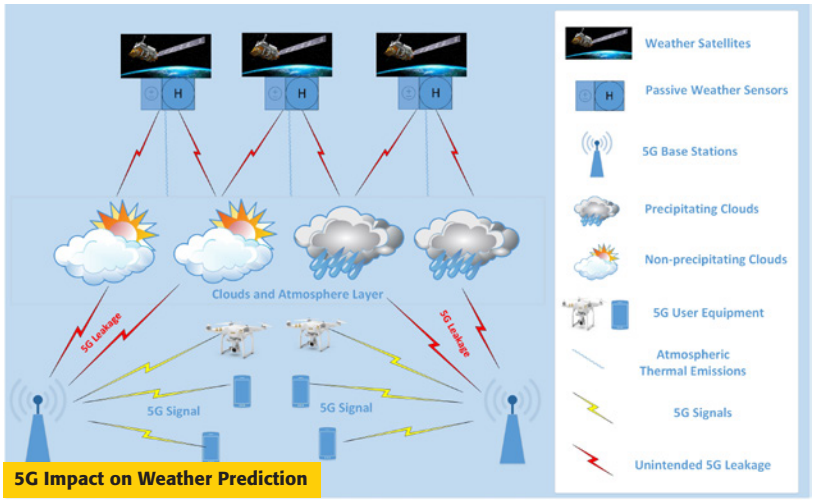
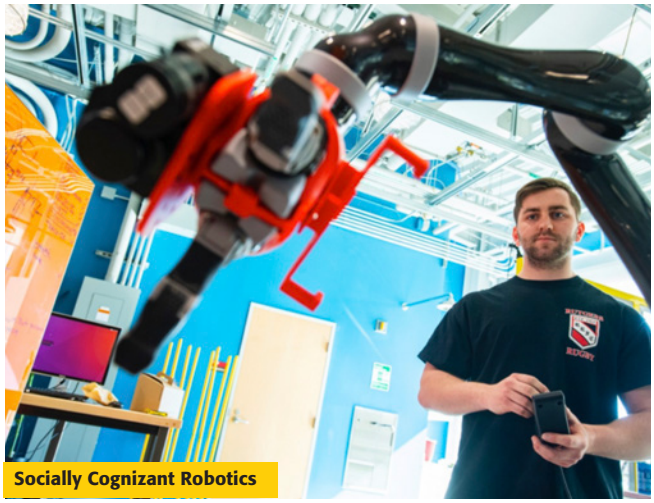
# ecenews

**Rutgers University School of Engineering** | Department of Electrical and Computer Engineering | 2020



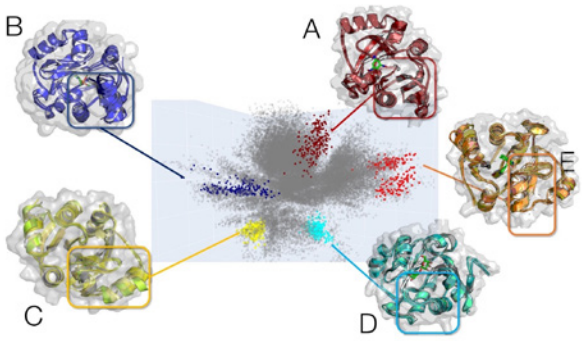
5G Impact on Weather Prediction


Socially Cognizant Robotics

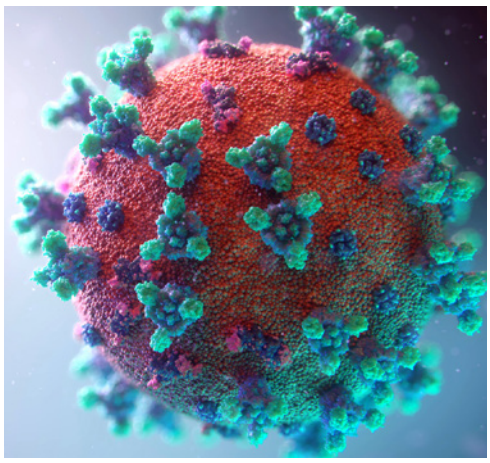



IEEE VexU Robotics Champions


M. Javanmard



COVID Drug Discovery



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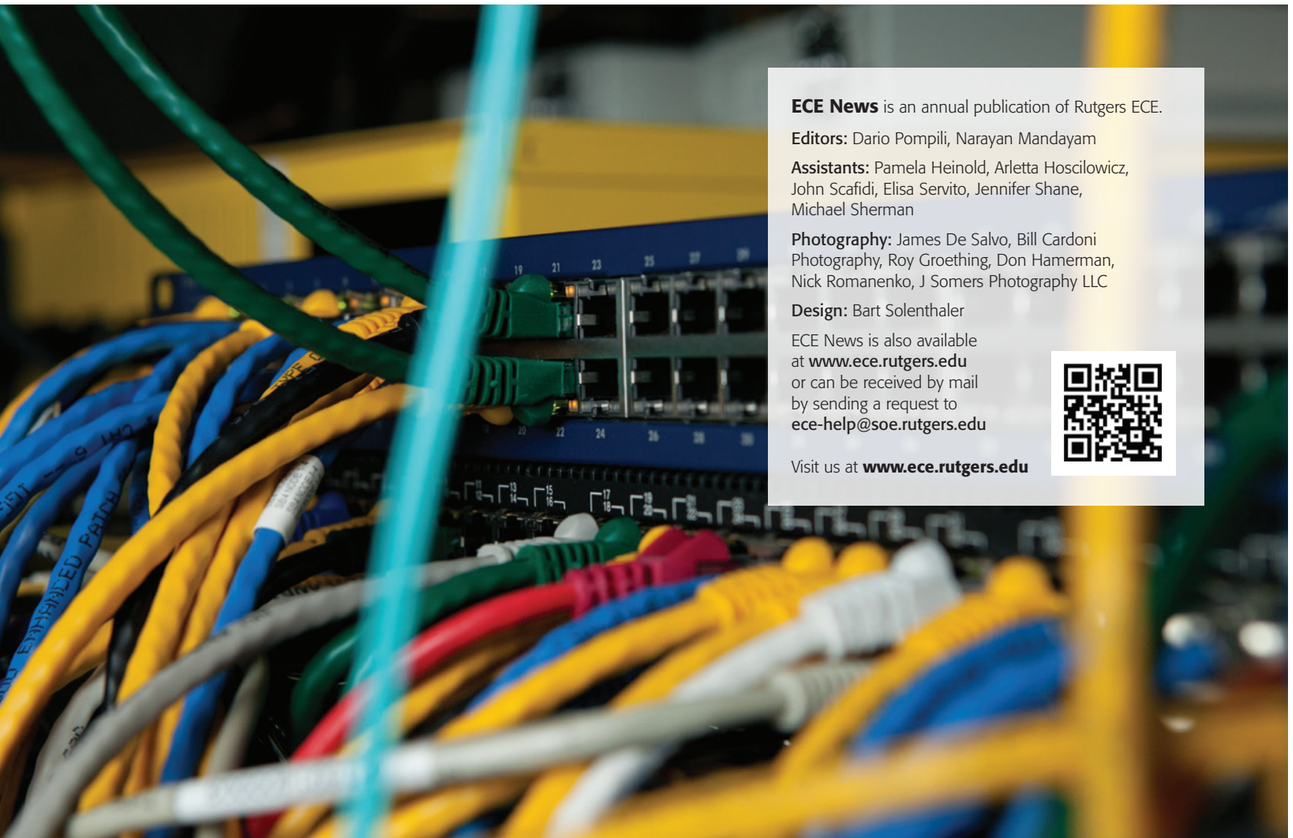


**ECE News** is an annual publication of Rutgers ECE.

**Editors:** Dario Pompili, Narayan Mandayam

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**Design:** Bart Solenthaler

ECE News is also available at **www.ece.rutgers.edu** or can be received by mail by sending a request to **ece-help@soe.rutgers.edu**

Visit us at **www.ece.rutgers.edu**


# message from the Chair

N. Mandayam

**ECE Numbers**

**38**
Faculty

**4**
Part-Time Lecturers

**825**
Undergraduate Students

**240**
Graduate Students

**120**
PhD Students

New Research Grants:
**$15,900,000**

Space:
**40,000 sq. ft.**

This has been and continues to be one of the most challenging and yet most rewarding years as Chair. The global pandemic, which has brought a myriad of challenges to the way we normally do business, has also inspired our faculty, staff, and students alike to show resiliency and rise up to meet and overcome these challenges. Our ECE faculty colleagues have innovated and improvised to offer our students a remote and virtual pedagogical experience, be it for instructional classroom lectures or hands-on laboratory exercises. Our students have adapted remarkably well to this new mode of instruction. And our departmental staff have been the pillars without whose support we could have not managed this. ECE Professors **Shantenu Jha, Mehdi Javanmard** and **Umer Hassan** have been at the frontlines of the fight on COVID-19 with their research groups leading efforts on high performance computing and microfluidics for drug discovery.

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 **Laleh Najafizadeh** (Provosts Award for Excellence in Cross-Disciplinary Research), Professor **Anand Sarwate** (Board of Trustees Research Fellowship for Scholarly Excellence), Professor **Mehdi Javanmard** (2020 DARPA Young Faculty Award), and Professor **Yingying Chen** (IEEE Fellow and Peter Cherasia Faculty Scholar Award). Distinguished Professor **Athina Petropulu** was elected President of the IEEE Signal Processing Society and Professor **Dario Pompili** was named 2019 ACM Distinguished Member. ECE faculty members were also part of teams that won multiple best paper awards: Professor **Wade Trappe** (2019 IEEE Wireless Communications and Networking Conference) and Professor **Sheng Wei** (2020 ACM Multimedia Systems Conference). Professor **Kristin Dana** was the recipient of a NSF National Research Traineeship award in the area of contextual robotics. Professors **Chung-Tse Michael Wu** and **Narayan Mandayam**'s research on 5G networks and their potential to affect the accuracy of weather forecasts was featured in the popular press. Like the year before, this year too was marked with a large number of external grants with the department's external research expenditures increasing by 30% over the last two years.

ECE Ph.D. students **Zhuoran Qi** and **Xueyuan Zhao** working with Professor Pompili won the Best Paper Award at the 2019 ACM International Conference on Underwater Networks & Systems. A Rutgers student team led by ECE Ph.D. student **Mehdi Rahmati** and supervised by Professor Pompili shared the first prize in the 2019 IEEE Communications Society (COMSOC) Student Competition for their project titled "LICOT: Litter-Information-Centric Ocean of Things." ECE Ph.D. student **Zhenzhe Lin** working with Professor Yingying Chen won the Best Paper Award at the 6th EAI International Conference on IoT Technologies for HealthCare. ECE Ph.D. students **Mohammad Yousefv** and **Wuyang Zhang** won the IEEE COMSOC Phoenix ISS Scholarship. **Sukhjit Singh,** an undergraduate student in ECE working on an NSF REU grant, won the Best Outreach Efforts award at the 2019 American Society of Mechanical Engineers International Mechanical Engineering Congress & Exposition's poster competition. An ECE team of seniors **Rameen Masood, Purna Haque, Nga Man Cheng,** and **Holly Smith**, won a $4,000 prize at the 7x24 Exchange Metro New York 2020 Virtual University Challenge as part of their capstone design project.

Consistent with this excellence, ECE student enrollment remains the highest in the School of Engineering, with our undergraduate enrollment in the sophomore year exploding from 268 to 350 students. In keeping with the national trend in the US, our graduate student enrollment in the Master's program is down due to the pandemic and travel restrictions. Our students upon graduation, continue to be 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 page 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, fund student travel to conferences, and maintain state-of-art laboratories.

I am very proud of the accomplishments highlighted in this newsletter. We all miss being on campus and hope to be back sometime in the near future. At that time, if your travels bring you to our area, I hope you can visit us to experience up close the vibrancy of this department.

Sincerely,

Narayan Mandayam
Distinguished Professor and Chair

# ecefaculty

**Waheed U. Bajwa**
**Associate Professor**
NSF Career Award, ARO YIP Award
**Research Interests:** statistical signal processing, high-dimensional statistics, machine learning, and networked systems.

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

**Yingying (Jennifer) Chen**
**Professor and Graduate Director**
IEEE Fellow, Peter D Cherasia Endowed Faculty Scholar, 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, applied machine learning, hardware-software co-design.

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

**Salim El Rouayheb**
**Associate 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**
**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, resource 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**
**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**
NSF Initiation Award,
Rutgers Monroe Faculty Scholar,
Faculty of the Year Award (2019)
**Research Interests:** Micro- and nano-electronics multifunctional oxides - based 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**
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
**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, ACM Distinguished Scientist
**Research Interests:** Wireless networking, underwater communication, Mobile Edge Computing, Internet of Things, Autonomy.

**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.

**Anand D. Sarwate**
**Associate 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, modern state-space based approach used to both model and analyze electronic circuits.

**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, information, and queuing 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**
**Associate 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 and system security, Multimedia systems.

**Chung-Tse (Michael) Wu**
**Assistant Professor**
NSF Career Award, DARPA Young Faculty Award
**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 Presidential Early Career 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 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.

**Yinglung Liang**
**Part-time Lecturer**
Verizon
**Expertise:** Software engineering and data science.

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

# studentnews

## Senior Spotlight
## Mohammad Nadeem, ENG '20


M. Nadeem

Choosing to attend Rutgers School of Engineering was an easy decision for **Mohammed Nadeem**, who graduated in May as a computer engineering major in the Department of Electrical and Computer Engineering (ECE). "I knew the research opportunities were pretty good – that was the main attraction," he says.

From the start, the Cherry Hill, New Jersey native wanted to study technology and electronics. "I really like software engineering and machine learning," he explains. Even more important, "I liked the fact that undergraduates could do research with whatever professor they wanted to, as ECE professors are pretty open to that idea." As a result, in his junior year, Nadeem joined the Cyber-Physical Systems Laboratory (CPS Lab) run by ECE professor **Dario Pompili,** where he was exposed to – and engaged in – graduate-level research.

Nadeem recalls that after receiving an email saying the lab was looking for people to work on a new project, he looked into it. "The project was very interesting, as it worked with programming an underwater robot to perform autonomous tasks. I thought that would be pretty cool. There are self-driving robots, cars, and drones – but nothing underwater, which made this a really unique project."

As part of the research team, Nadeem programmed the remotely operated underwater vehicles to take adaptive sampling for near-real-time water-quality assessments. The samples would be able to be stored for subsequent retrieval for analysis.

Pompili recalls, "He finished his spring semester research by designing a distributed sampling algorithm that used consensus to determine which vehicles should sample which areas. Afterward, the research expanded into using multi-agent reinforcement learning to conduct adaptive sampling."

Nadeem gained first-hand experience in publishing when he co-authored a research paper under the guidance of Pompili and ECE doctoral students. The paper, which presented CPS Lab research regarding optimized sampling, was published in the Association for Computing Machinery (ACM) International Conference on Underwater Networks and Systems (WUWNet) in October 2019.

"I like working on interesting problems," says Nadeem. "The CPS Lab gave me the ability to do that while also working in so many different areas of engineering. The work I've done has really broadened my knowledge and given me a lot of experience."

It is experience and knowledge that earned Nadeem and fellow team members First Prize – tying with students from MIT and Peking University – in a prestigious Institute of Electrical and Electronics Engineer's competition last fall. "We basically used the underwater vehicles to create a network able to monitor marine pollution," he explains.

In addition to research opportunities, Nadeem has enjoyed the freedom and flexibility to take different classes in different departments and gain new knowledge. He is convinced that this is one of the biggest advantages of being a Rutgers student.

He also enjoyed the experience of serving on a planning committee for the Muslim Student Association (MSA) during his sophomore year, as well as being a member of ECE Honor Society, Eta Kappa Nu – and encourages new students to be active in extra-curricular activities right away. Nadeem is eager to start a year-long software engineering residency with Google in New York City come summer. "I'll receive two months of training in Google products and tools before doing a rotation through two teams for five months each," he explains. Residents in this highly desirable program are likely to be hired after the year is up.

Taking a longer view, Nadeem also looks forward to giving back to the school. "I benefited from scholarships – and it would be really nice if in the future I could donate some money and help someone else with their tuition."





## Detecting Acoustic Back Door Transmission of Inaudible Messages Using Deep Learning


M. Kasher


M. Zhao

Undergraduate students **Morriel Kasher** and **Michael Zhao** completed their honors research project "Detecting Acoustic BackDoor Transmission of Inaudible Messages Using Deep Learning" this summer under the mentorship of Dr. **Silvija Kokalj-Filipovic** of Perspecta Labs, Inc and Professor Predrag Spasojevic. Their paper was presented at the 2020 ACM Workshop on Wireless Security and Machine Learning in July 2020. The project took one year to complete and combined aspects of acoustic communication, digital signal processing, and machine learning.

In the past decade, microphones have become increasingly prevalent in everyday life. From voice-enabled devices like Alexa and Google Home, to personal assistants like Siri and Cortana, accurate voice recognition is now critical to many basic tasks. However, most take for granted that acoustic transmissions (that is, audible sounds) are secure and cannot be replicated. It was long thought that the only way to manipulate a voice-enabled device was by actually playing a sound and having it be recorded. The project applies a technique known as BackDoor, which allows the audible recording of inaudible sounds by any unmodified microphone. By carefully processing the audio beforehand, one can control exactly what the microphone records, even though none of it is audible to humans. A method was developed to detect transmission using this BackDoor system through the use of deep learning algorithms. The project was the first of its kind to combine the hardware aspect of BackDoor with a software-based deep learning method for the detection of such attacks. The research results strongly support the use of deep learning to detect BackDoor transmissions, and serve as a starting point for future research into the field. Morriel and Michael hope to continue working on related research during their undergraduate studies, and are grateful to Dr. Kokalj-Filipovic and Professor Spasojevic for their guidance and mentorship.

## Rutgers IEEE oversees the South Brunswick High School VEX Robotics Competition

On Saturday, February 1st, 2020 the Rutgers Institute of Electrical and Electronics Engineers Student Branch (RIEEE) conducted the South Brunswick High School VEX Robotics Competition (VRC). The event was attended by 36 teams of high school students from all over New Jersey and over 500 students and parents came. Of the 36 teams competing, only 3 get to move on to the State Championships, by earning the Excellence Award or being the Tournament Champions (2 teams).

This year's competition was Tower Takeover, where 4 teams in 2 alliances are pitted against each other to stack as many cubes as they can in their alliance goal zones. They can also multiply their points by putting cubes in elevated towers. Teams must first compete in an autonomous portion of the match where they can get an early lead by having the robot navigate the course by itself. Immediately afterward driver control starts. The match takes a total of 2 minutes.

The Rutgers IEEE Student Branch ran inspections, refereed the matches, and judged all 36 teams during the course of the day. 9 awards were given out to deserving teams, including the Excellence, Design, Judges, Build, and Amaze awards.

Congratulations to Tournament Champions Union Senior High School (Team 161A), South Brunswick High School (Team 750S) and Excellence Award Winner Union Senior High School (Team 161A). Teams 750S (SBHS), 750X (SBHS) and 161A (Union) will be moving on to the State Tournament.

The event received a lot of positive responses from the Event Partners at SBHS, students and other coaches and parents attending. Students are mentioning that compared to other competitions, the referees took their time explaining the rules when infringed upon, and allowed a feedback and cross debate. In addition, due to the dedication of the volunteers and months of planning, the teams had an amazing time competing with the robots they spent so much time working on. Rutgers IEEE will be running the Monroe High School VRC Competition this coming weekend.

# Students become Faculty


D. Kalogeries

## Dionysios Kalogerias

Born in Zakynthos, Greece, in 1986, and after getting an MEng and an MSc from the University of Patras, Greece, in 2010 and 2012, respectively, Dionysios came to the US in 2012 to pursue a PhD at Rutgers ECE under the guidance of Prof. **Athina Petroupulu.** During five wonderful PhD years at Rutgers ECE, he contributed and published extensively on core topics in statistical estimation, stochastic optimization and wireless communications, and he received several awards for his work, including both the 2017 Rutgers ECE Graduate Program Academic Achievement Award and the 2017 Rutgers SOE Outstanding Graduate Student Award, as well as the Best Student Paper of the Special Sessions Award at IEEE ICASSP 2016. After his graduation in June 2017, Dionysios joined the Department of Operations Research and Financial Engineering (ORFE) at Princeton University as a postdoctoral research associate, where he worked on the development of computationally efficient algorithms for risk-aware optimization and learning, and also large-scale supply scale management and simulation. In June 2019, he joined the Department of Electrical and Systems Engineering at the University of Pennsylvania as postdoctoral researcher, where he has since been working on reinforcement learning, machine learning for wireless communications, wireless autonomy, and also risk-aware Bayesian estimation and control, a fundamental new concept for which he also received the Best Student Paper Award at IEEE ICASSP 2020. Since August 2020, Dionysios has been an assistant professor with the Department of ECE, Michigan State University. His research blends the elements of a diverse research experience, and focuses on enabling trustworthy and robust wireless autonomy by leveraging and developing tools spanning the areas of machine and reinforcement learning, optimization and control, and signal processing.

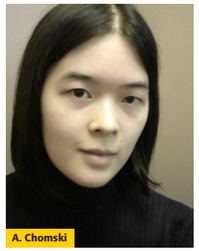

M. Rahmati

## Mehdi Rahmati

Mehdi is an IEEE senior member and a tenure-track assistant professor in the Department of Electrical Engineering and Computer Science at Cleveland State University, Ohio since August 2020. He received his Ph.D. in Electrical and Computer Engineering (ECE) at Rutgers University working with Prof. **Dario Pompili** in the Cyber-Physical Systems Laboratory (CPS Lab). Before joining Rutgers in 2013, he was a full-time faculty member in Iran, taught more than fifty different courses in ECE and Computer Science programs at different universities, and was recognized as an Exemplary Lecturer in 2010.

His research interests lie primarily in the field of wireless communications and networks. He conducts research to design novel algorithms, protocols, and systems for robust, reliable, and high-data rate multimedia transmissions in uncertain and extreme environments, such as the underwater environment. He has published many peer-reviewed conference and journal papers and has received multiple prestigious awards including the first prize (ex aequo) in 2019 IEEE Communication Society (ComSoc) student competition, the best demo award at 2019 IEEE International Conference on Sensing, Communication and Networking (SECON), the best paper award at 2018 IEEE MIT Undergraduate Research Technology Conference (URTC), the best paper award at 2017 IEEE International Conference on Mobile Ad-hoc and Sensor Systems (MASS), and the best paper runner-up award at 2015 ACM International Conference on Underwater Networks and Systems (WUWNet). He is also the recipient of the Rutgers/ECE research excellence award in 2018, Rutgers School of Graduate Studies conference travel award in 2018, and 5 other National Science Foundation (NSF) conference travel awards. Mehdi has conducted technical reviews for numerous journal and conference papers, and served as a Technical Program Committee (TPC) member at many international conferences. His current research focuses on novel solutions for distributed robotics and Internet of Things (IoT) in dynamic environments.

# Meet an ECE Student


A. Chomski


M. Johnson


C. Norton


S. Salsabilian

## Ariela Chomski

I'm a rising senior majoring in Electrical and Computer Engineering with a minor in Computer Science. I joined Rutgers IEEE in my freshman year when I attended Python classes taught by other students through the N2E division (Novice 2 Expert Coding). In my sophomore year, I joined the Rutgers IEEE VEX Robotics team. These experiences really helped me develop my interpersonal skills by working with my peers in a more hands-on environment than my classes. This past year, as the club's Treasurer, I helped organize and arrange funding for dozens of professional development events, competition entries, and volunteering opportunities. Our VEX Robotics team qualified for the World Championship for the first time and it was our most sponsored competition entry. Unfortunately, the competition and a number of our other events had to be cancelled due to the coronavirus pandemic so I helped organize online events for the remainder of the semester through our Discord server. As President next year, I hope to be able to increase our club's online platform as well as transition division meetings online as smoothly as possible for the fall semester.

Being part of Rutgers IEEE has helped me grow by giving me opportunities to introduce engineering to younger students. I've been part of Young Engineers Day where we taught digital logic design basics to high school students as well as Prospective Student Tours, where I got to speak to prospective students about personal projects I've worked on and my experience in engineering. These experiences also helped me in my work as a Learning Assistant for the introductory MATLAB course at Rutgers, where I teach students problem-solving techniques and help them better understand the material.

During the summer after my freshman year, I worked as a Research Assistant with Georgiana Haldeman, a doctoral student in the CS department. Together with my research group, we analyzed data from student submissions to generate better errors for the autograder used in introductory Java classes at Rutgers. The following summer, I interned at National Grid, an energy company in NYC, in their corrosion department. There, I learned about the electrical engineering involved in corrosion and developed scripts to automate analysis of annual federally-mandated corrosion testing. This summer, I'm interning at L3Harris in the Space & Airborne Systems segment, working alongside Prof. Phillip Southard. I'm working to develop scripts for linting for VHDL code used in FPGA devices.

In my professional career, I'd like to apply what I've learned in my engineering studies to environmental or public infrastructure issues. I'm so thankful for the experiences I've had and knowledge I've gained from my time in the ECE department and am looking forward to what the future has in store!

## Myles Johnson

I am a Rutgers senior student-athlete studying Electrical and Computer Engineering while playing on the men's basketball team. I was raised in Southern California, born to Rick and Gigi Johnson. I graduated from Long Beach Polytechnic high school, which was selected by Sports Illustrated as the "Sports School of the Century." I am a two-time Big Ten All-Academic honoree (2019-20 and 2018-19) and was recently named to the National Association of Basketball Coaches Honors Court.

At almost 7 feet tall, I was fortunate to have had numerous basketball scholarship offers to attend a variety of prestigious schools across the nation. I chose Rutgers because it was the best of both worlds both academically and athletically. I am able to compete on the basketball court in one of the best conferences in the nation, while also attending Rutgers School of Engineering ranked amongst the top 50 in the country.

Being a member of the basketball team at Rutgers as well as being part of ECE does sound daunting, but the ways I stayed on top of things is due to my time management skills. Having to balance having a social life, homework, eating and sleeping properly, and studying can be difficult for normal students, and adding practice, working out, games, and traveling for competition makes it even harder. I'm fortune that I embody anti-procrastination, as well as have an academic advisor and understanding professors who understand the hurdles I face and are flexible to adjust to my needs. The other schools I visited, before committing to Rutgers, didn't have a system in place for athletes who desired to be engineers, it was either change your major or move on, and I'm happy I stood my ground and found Rutgers.

I would tell first year students the ECE program consists of such a wide range of possible professions, not just coding or circuit work, which comes to mind when hearing "Electrical and Computer Engineering". There are many interesting classes that extend past the bubble of what is expected. For example, I took a 3D CAD modeling course which was quite interesting and expanded my skill set.

Early on as a child, I loved to play with Legos and was always interested in science, math and technology. I also participated in many extracurricular activities involving STEM. One of favorites being Saturday Science, which provided me with a weekly dose of STEM activities and experiments. Besides these activities, my father, is an electrician for the Los Angeles Unified School District, and his sister received her Master's in Electrical Engineering, so it's safe to say engineering might be in my genes.

I would tell students not to shy away from classes that are deemed "difficult." I learned a lot of valuable skills from classes that people said were "too hard." Also, never lose focus. It's easy to get caught up in life and everything going on around you, but as long as you keep a clear head and set obtainable goals, you can find success.

My main focal point is Electrical Engineering, however, one great benefit of ECE at Rutgers is that the difference between majoring in Electrical Engineering and Computer Engineering in quite slim, so over the course of my degree I've been able to take classes that pertain to both majors. Once I graduate I would like to use my education and skills to work with renewable energy and/or hardware design.

I have been so lucky to have great professors at Rutgers but my favorite has been Dr. **Mehdi Javanmard**. Dr. Javanmard was my Electronic Devices professor and his class was a great precursor to the world of electrical engineering. He gave me strong foundation and base knowledge needed to get through the rest of electrical engineering. Without his guidance I would not have been able to continue on with the more advanced electrical engineering classes.

Since I will have one more year of NCAA eligibility, I will be continuing my education at Rutgers to obtain a Master's degree. Although I haven't yet determined exactly which master's program to pursue, I look forward to earning two prestigious Rutgers degrees. After graduate school, I plan to move back to California to pursue a career in renewable energy and/or hardware design.

My dream scenario throughout middle and high school has remained unchanged throughout my progression through ECE. I would want to work for a big name tech company in the Silicon Valley, using my engineering knowledge to create new and improving technology. I see myself being part of the electrical energy revolution, as I believe in five years' time the world will be more reliant on electrical energy as a primary power source, in everything from cars, to houses, to industrial purposes.

Build as many connections as you can from the start. Many of your fellow students will go on to do great things, having good people in your corner as a resource and building a substantial network early is a huge advantage.

I am currently developing a non-profit organization called BLKdev aimed at getting more Black children interested in the fields of STEM, by introducing them to fun and easy to use educational resources. On our site we also list various scholarship opportunities, and have a newsletter highlighting any news articles pertaining to Black people in STEM. The future goals of my organization is to create our own scholarship fund as well as host educational events to teach paratactical STEM skills to the upcoming Black generation. I used the knowledge I learned in Rutgers ECE program to create the website for our organization, check it out at Blkdev.org.

I've had so many great experiences at Rutgers with so many memories. One in particular that stands out combines my engineering world and my athletic world. During my sophomore year after losing a tough game to Seton Hall in our annual rivalry game, I took a photo with some of my fellow Engineering students and Dean Vargas. The students were so happy that I was representing engineers in a place where there are very few. That moment, knowing they were there to support and cheer for me, created a feeling of family, which is something I can't say I would have gotten anywhere else.

Besides playing basketball I have a passion for cooking, culinary school was actually my plan B. I am also a huge anime fan, from the main stream shows to the hidden gems few know about. Lastly, I also enjoy traveling - I've been to almost all 50 states and 9 countries so far. My favorite toy hands down are Legos, and I recently have become heavily invested in small Arduino and Raspberry pi projects.

## Corey Norton

I was lucky enough to graduate from the Electrical and Computer Engineering (ECE) department twice: first with my Bachelor's degree in 2018 and then again with my Master's degree in 2020. During my undergraduate years I could not decide on a single area of focus, so I explored both the fields of environmental sustainability and biotechnology through Rutgers courses, extracurriculars, and internships. To gain biotechnology experience, I held a position as an Engineering Intern for Sterling Medical Devices where I had the opportunity to work on several life-saving medical devices for use in clinical settings. To gain experience in environmental sustainability, I studied renewable energy in Reykjavik, Iceland over winter break thanks to a study abroad program called The Green Program.

While both of these experiences gave me a deeper appreciation for engineering, I did not find my true passion until I joined the Rutgers chapter of Engineers Without Borders. With this organization I was able to work on several international engineering projects, eventually becoming a Project Lead and travelling to Karatu, Tanzania to begin assessment for a water supply and distribution project that is currently in development. As my senior capstone design project, I also designed an automated irrigation system for the chapter's community garden project in Camden, NJ with help from my faculty advisor, Dr. **Hana Godrich**.

During my graduate years, I honed my professional focus on biotechnology as a founding member of Dr. Umer Hassan's lab, while also remaining an advisor to the Rutgers chapter of Engineers Without Borders. As part of my thesis research, I developed an electromechanical biosensor to monitor the immunoresponse of septic patients. I worked in conjunction with Robert Wood Johnson University Hospital to test this device with biological samples, and I am currently in the process of publishing the study. Outside of the lab, I served as a Teaching Assistant for several of the department's undergraduate courses and as a Program Architect for USTEM, a non-profit organization that develops and administers free afterschool STEM programs for K-12 students.

Rutgers is an exciting place with a lot to offer, and I am honored to be a part of such a passionate community of engineers. As I look now to beginning my career in the biotechnology industry, I thank the Rutgers ECE department for being an amazing home to me these past 6 years, and I hope it continues to inspire many future generations of engineers as it has me.

## Shiva Salsabilian

I am a Ph.D. candidate in Electrical and Computer Engineering (ECE) at Rutgers University working with Prof. **Laleh Najafizadeh** in the Integrated Systems and NeuroImaging Laboratory.

Before joining the Rutgers University at 2017, I graduated with M.Sc. degree also in Electrical and Computer Engineering from the Isfahan University of Technology (IUT) in Iran, with my thesis being on signal detection and spectrum allocation in cognitive radio systems through signal processing techniques.

I then realized my real passion is to use the engineering and data analysis skills that I have learned in understanding brain functionality and perusing solutions for problems in neuroscience and healthcare. Through my multidisciplinary research in the NeuroImaging lab. which covers interesting topics at the intersection of engineering and neuroscience, I have been working on multiple projects.
In my first project, I developed an analysis framework to analyze the neuroimaging data and investigate the brain dynamics at the network level (i.e., brain functional networks) to extract features which can be used to decode behavior and give a better scientific understanding of the brain mechanism underlying behavior. This study resulted in papers such as "Using connectivity to infer behavior from cortical activity recorded through widefield transcranial imaging" which was orally presented in the conference of OSA Biomed 2018. Inferring about the behavior, intent, or the engagement of a particular cognitive process from neuroimaging data finds applications in several domains including brain machine interfaces.

In another interesting project, I worked on developing a data-driven method to find effective discriminative biomarkers for the early diagnosis of brain injury from recorded neuroimaging data following the injury. Result from this research help in early diagnosis of brain injury, understanding compensation mechanism of the brain, and ultimately toward effective and timely rehabilitation. Our work on this project has been documented with several conference and journal papers like "Quantifying Changes in Brain Function Following Injury via Network Measures" and "Detection of Mild Traumatic Brain Injury via Topological Graph Embedding and 2D Convolutional Neural Networks" which have been orally presented at the Annual International Conferences of the IEEE Engineering in Medicine and Biology Society (EMBC) 2019-2020.

In my ongoing project, I am investigating temporal evolution of the brain dynamics at the network level during the memory and learning mechanism. I am focusing to figure out how brain networks change in response to memory and learning tasks.

I have received the Rutgers ECE student Research Excellence Award in 2018, Rutgers School of Graduate Studies conference travel award in 2018, and Rutgers TA/GA Professional Development Award 2018.

I am so grateful that I had the opportunity to pursue my Ph.D. at Rutgers University. Rutgers has helped me develop personally and professionally. The ECE department at Rutgers with knowledgeable world-class faculty provides a great opportunity and support through the educational and professional growth.

# Rutgers Senior Daniel Toth Salutes College and Navy ROTC Training

Margaret McHugh for Rutgers Today


Daniel Toth at the Navy ship selection ceremony when he learned he will be stationed aboard the USS John S. McCain, based in Yokosuka, Japan. Photo credit: Nick Romanenko

When **Daniel Toth** was living on campus, he would report at 5:30 a.m. for a fitness regimen followed by a naval science class — all before starting his days as a student at Rutgers University. The Navy ROTC midshipman's favorite workout has been the "strip swim." Dressed in uniform and boots, he and his colleagues would jump into a pool, then take off an article of clothing every 250 meters they swam. "You don't see the swim team doing that!" he said.

After four years of hard work, Toth found out in a recent tense moment that he achieved his goal: getting to serve aboard the USS John S. McCain, based in Yokosuka, Japan.

"It's all paid off – all that work and all the early mornings. Getting your first choice of ships is hella-nice!" Toth said, as soon as he found out during the annual midshipman selection ceremony.

The Navy ROTC ship selection ceremony involves sitting before a live video feed with the Navy Bureau of Personnel in Millington, Tennessee. Students reveal where they hope to serve and then find out if they get their first choice.

The electrical engineering major at Rutgers University-New Brunswick ranked 20th out of 300 Navy ROTC midshipmen at 77 colleges nationwide in the Surface Warfare Officers-Nuclear track. His odds on selection day were good, but there was no guarantee the 19 midshipmen ahead of him wouldn't nab the one slot he sought.

But when the time came, the host called his name, and Toth's image appeared next to hers on the screen. He gave a polite greeting, then calmly announced his choice. The host turned her head to the right for a few seconds, then turned back and said, "You got it!"

A grin spread across Toth's face and applause erupted in the headquarters of the Rutgers University/Princeton University Navy ROTC Unit in New Brunswick.

The 22-year-old Middletown native said he is "beyond excited. I've been ready to go for a year!" Toth will become an ensign at the Navy ROTC's commissioning ceremony, which will be held virtually this year on May 18.

Toth is one of 42 students from Rutgers ROTC programs, and one of nine from the Navy ROTC, who completed the extra challenge of military training while working on their Rutgers degree. Eight students are graduating in the ROTC Air Force program and 25 are graduating from the Army ROTC.

Toth's mother, Joli, watched the draft on YouTube, and said she was thrilled for him. "We're all very proud," she said. "He's very driven in everything he does."

Joli Toth said her father served in the Navy, and she has long hoped that one of her five children would join the military. Daniel Toth's mother, father and older brother are all Rutgers alumni, and his sister is a sophomore at Rutgers-New Brunswick.

During the 18 to 24 months on the USS John S. McCain, Toth will be assigned a division and oversee 10 to 30 sailors. He'll also learn to drive the destroyer. "That will be his real introduction to the Navy," said Lt. Mark Hammerquist, who oversees the Surface Warfare Officer-Nuclear midshipmen. "We're very excited for him."

"He worked really, really hard to get this opportunity to serve in the fleet," said Capt. Andrew F. Smith, commanding officer of the Rutgers University/Princeton University Navy ROTC Unit. Toth will spend the following two years training to operate nuclear reactors, which power the Navy fleet.

Growing up by the Jersey Shore, Toth said he happily spent his days on the beach. He never so much as stepped foot on a boat until enrolling in a U.S. Naval Academy program on a whim the summer before his senior year of high school. He applied to the Navy ROTC that fall.

Since then, he's spent summers training on ships. "I really like the technical side of things," Toth said.

Balancing the demands of the Navy ROTC program and maintaining a 3.7 GPA in Rutgers Honors College during his college career has been a challenge.

Toth's leadership responsibilities with his 65-member Navy ROTC unit have increased over his years at Rutgers. Last fall, he organized its Navy birthday ceremony and military ball. As busy as his schedule is, he still finds time to participate in intramural volleyball and softball, he said.

Toth said he has not traveled internationally – his family spends vacations visiting family in Hawaii, his mom said. He chose the USS John S. McCain in large part for the overseas experience it offers. "I want to sink my feet into a totally new side of the world," he said.

The ship is also in what's considered a forward-deployed area, meaning that it is at sea more frequently than others and "the operational tempo is higher," Toth said. That, he expects, will allow him to acquire greater experience sooner.

Since Rutgers moved to remote learning for students in response to COVID-19 and no Navy ROTC activities happening for the rest of the semester, Toth will complete his engineering classes online and continue to work out five or six days a week from home.

"It's kind of an anticlimactic end to a pretty eventful four years," he said. While he's disappointed there will be no in-person commencement this May, he's looking forward to spending three months at ship-handling training in San Diego before boarding the USS John S. McCain.





# Rutgers IEEE VexU Robotics Team wins Tournament Championship and competes in 2020 VexU Robotics World Championship


The Rutgers IEEE VexU Robotics division competed in the Widener University Robotics tournament in Chester, Pennsylvania against teams from New Jersey, Pennsylvania, and Maryland. RIEEE brought two teams, SKAR (Scarlet Knights at Rutgers) and RUSK (Rutgers University Scarlet Knights) to this competition. The teams consisted of:

- **Tim Petersen,** ECE-20′
- **Israel Jackson,** MAE-20′
- **Agam Modasiya,** MAE-22′
- **Jack Lowry,** ECE-23′
- **Akash Pathuri,** ECE-23′
- **Rakesh Warrier,** RBS-23′
- **Josh Chung,** CS-23′
- **John Plaras,** ECE-21′
- **Haolin Jim,** CS-23′
- **Karun Kanda,** CS-22′
- **Felix Shames,** ECE-22′
- **Damian Modzelewski,** MAE-21′

The game in this competition consisted of stacking cubes in corners and placing cubes in towers. The first 45 seconds of each match are autonomous, while the rest of the match is driver control. The team ran into some issues at the start of the competition with their autonomous program, but they were able to debug and practice overnight. They placed third in the skills challenge as well as third in qualifiers. During the first round of eliminations, they earned a bye week. They then beat the College of Southern Maryland 18-16 in the semi-finals. They went on to face NJIT in a best of three Final. Twice in a row, NJIT was defeated 25-16, 44-41. With these wins, they secured the Tournament Champions Award along with the design award for their outstanding Engineering Notebook. The team is planning on attending the Cardinal Classic competition in Baltimore, Maryland on January 25th where they hope to qualify for the World Championship.

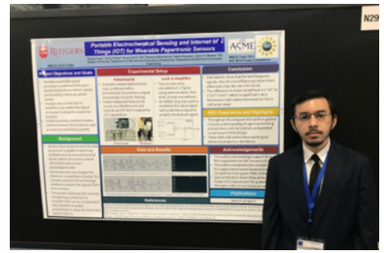
After winning Tournament Champions and the Design Award at the Widener University Competition, the Rutgers IEEE VexU Robotics team aimed higher after missing out on a World tournament spot. They traveled to Baltimore, Maryland to compete in the VexU Cardinal Classic competition. This time, they only brought one team, SKAR (Scarlet Knights at Rutgers), to compete. Of the over a dozen people who worked on the bots throughout the year, the team members who traveled to Maryland were:

- **Agam Modasiya**
- **Akash Pathuri**
- **Rakesh Warrier**
- **Josh Chung**
- **Karun Kanda**
- **Damian Modzelewski**

Competing against teams from Massachusetts, New York, New Jersey, Rhode Island, Virginia, Pennsylvania, and Maryland, the Scarlet Knights were able to get second in Skills and fourth in Qualifications. After moving on to the elimination tournament, they lost to the eventual tournament champions due to a disqualification. After sticking around to cheer on their fellow New Jersey team, NJIT, the team was awarded the excellence award, which qualifies them for the 2020 Vex Robotics World Championship competition in late April where they would have competed against teams from China, Mexico, New Zealand, and other teams from around the globe.

The World Championship competition was canceled due to the Covid-19 pandemic.

# ECE undergraduate recognized for research in Portable Electrochemical Sensing



**Sukhjit Singh,** an undergraduate student in Electrical and Computer Engineering at Rutgers University, has won the Best Outreach Efforts award in the American Society of Mechanical Engineers International Mechanical Engineering Congress & Exposition (IMECE) 2019 NSF REU Student Poster Competition. He also received a travel grant to attend the competition, which took place in November in Salt Lake City.

Singh is a member of a research group led by Dr. **Aaron D. Mazzeo,** an associate professor of Mechanical & Aerospace Engineering at Rutgers University. The research team is composed of **Sukhjit Singh,** Dr. **Ramendra K. Pal** (Postdoctoral Associate), **Emily Gruber** (Undergraduate, ECE), **Sowmya Balakrishnan** (Undergraduate, ECE), and **Mark Orzeszko** (Graduate Student, MAE). The poster presents the team's work on Portable Electrochemical Sensing and the Internet of Things (IOT) for Wearable Papertronic Sensors. The project is funded by the National Science Foundation (NSF) grant #1653584.

"Studies have demonstrated that flexible biosensors are capable of detecting biofluids such as wound fluid and blood, which can convey critical information about one's physiological state. However, few biosensors can analyze the chemical composition of sweat (Ex: Lactate, Cortisol, etc.) and lack the technology needed to process the signals from these sensors," says Singh. "We address this issue by introducing a small lock-in amplifier that can be incorporated into a flexible wearable potentiostat to allow for noise-free sweat analysis. Applications of such a device include monitoring the health of athletes, soldiers, astronauts, and animals."

The 2019 ASME IMECE Track 16-2 NSF REU Student Poster Competition is a student-centered IMECE-wide poster session for research funded by the National Science Foundation.

Singh says his research goal is to develop new devices to continuously monitor the health of users and lower the cost of healthcare.

# 2020 ECE Capstone Awards

Thank you to all the students, advisers, faculty, and judges who took the time to join us today for the virtual capstone award ceremony!

Special thanks to **Dr. Mandayam** and **Dean Thomas N. Farris** for opening the award ceremony and for their address to our capstone students.

Before we announce the top ten projects, I would like to thank everyone involved with this year's capstone program:

**Capstone advisers:** Many undertook students guidance this year. We would like to thank the ECE faculty who supported the program and advisers inside and outside of Rutgers who contributed their time and effort to help our students. Their efforts and support are key to the success of our capstone program and the students learning experience. Thank you to all capstone advisers for your support!

**Capstone sponsors:** We would like to acknowledge the support of the following industry sponsors through funding and mentorship: **Siemens, Blackrock, JP Morgan, L3Harris, 7x24 Exchange Metro New York Chapter, Interactions LLC** and **MongodB**. Special thanks to **Elmer Galbi** for the generous projects awards sponsorship.

**Our panel of judges:** Many thanks to our judges for their effort and time taken to support and celebrate our students' achievements. The panel included: **Nikhil Shenoy** (Siemens Healthineers, BS'16), **Ashwin Sampath** (Qualcomm Inc., PhD'97), **Daniel Arkins** (Blackrock), **Don Bachman** (ASCO, BSEE, MBA), **Stephen Wilkus** (Spectrum Financial Partners), **Salman Hoque** (L3Harris Technologies, BS'19), **Anand Bhagwat** (JP Morgan, MS'91, MBA'94), **Dafna Shochat** (Blackrock, BS'19), **Kamal Abburi** (Microsoft), **Richard Huber** (AT&T), **David Galbi** (Galbi Research), **Soyab Khatumbra** (L3Harris, BS'15), **Ed Cordero** (Protiviti), **Srinivas Bangalore** (Interactions), **Donald Levy** (AT&T), **Marina Eskander** (Stantec, BS'17), **Ahmed Turk** (Samsung Electronics America, BS'02, MS'05), **Douglas Galbi** (FCC), **Gihan Oraby** (US Army, BS'02), **Ludwig Randazzo** (Juniper Networks, **Govindaraj Muthukrishnan** (Morgan Stanley, BS'17), **Harry Li** (MIT Lincoln Laboratory, BS'18), **Jonathan Ksiezopolski** (KAMTech Solutions, BS'16), **Marc Campos** (JP Morgan), **Mareesh Kumar Issar** (WINLAB, Rutgers University), **Umama Ahmed** (L3Harris, BS'19), **Bill Marushak** (Lutron Electronics), **Kshitij Minhas** (SRI International, BS'16), **Teddy Brown** (Verizon), **Shahab Jalalvand** (Interactions), **Zeid Abdulrazeq** (Verizon Wireless, BS'19), **Nazmul Islam** (Qualcomm, PhD'14), **Keon Kim** (Verizon Wireless, BS'19), **Nicholas Frost** (Morgan Stanley, BS'17), **Samuel Ramrajkar** (Ford Motor Company, MS'15), **Daniel Romero** (Verizon, BS'19), **Franke Hubertus** (IBM), **Sarah Hallac** (Blackrock), **Akanksha Pathak** (Verizon, BS'18), **Jane Luo** (Qualcomm, PhD'04), **Mhammed Alhayek** (Bloomberg, BS'18), **Ed Knapp** (American Tower), **Mike Dolan** (L3Harris, BS'99), **Joseph Conticchio** (L3Harris), **Jon Pucila** (Blackrock), **Nagi Naganathan**, and **Neharika Bhandari** (NBCUniversal, BS'18).

Your expertise, care, and insights where priceless in making the hard decisions as for the top projects.

**Capstone team:** A very warm thank you to our wonderful ECE team **Arletta Hoscilowicz, Pamela Heinold, John Scafidi, Kevin Wine,** and **Christopher Reid.** As always, their commitment and hard work throughout the year is the force behind the program. Many thanks to **Diksha Prakash** who worked tirelessly to support the capstone program around the year and to all the graduate and undergraduate students who helps with capstone events.

**FIRST PLACE**
(awarded $600, sponsored by Siemens)
Project S12-61: Agora VR: Virtual Reality Exposure Therapy of Agoraphobia & Social Anxiety Disorders
Team members: **Aryeh Ness, Daniel Nguyen, Michael Truong,** and **Ted Moseley**
Advisor: **Dr. Grigore Burdea**

**SECOND PLACE**
(awarded $400, sponsored by Blackrock)
Project S20-14: Refrigerated Delivery Drone System
Team members: **Peter Doroshenko, Alex Ameri, Eric Kraut, Philip Jeszeck,** and **Williear Glimniene**
Advisor: **Dr. Laleh Najafizadeh**

**THIRD PLACE**
(awarded $300, sponsored by 7x24 Exchange Metro NY)
Project S20-56: 2020Vision
Team members: **Roshni Shah, Shruthi Sureshkrishnan, and Nithyasree Natarajan**
Advisor: **Prof. Kristin Dana**

**FOURTH PLACE** ($100)
Project S20-51: Nephroto: Kidney Modeling App
Team members: **Christopher Basilio, Andrea Dumalagan, Parker Fisher, and Christian Remolado**
Advisor: **Dr. Deborah Silver**





**FIFTH PLACE** ($100)
Project S20-47: Low-Cost Ion-Selective Sensing for Hydroponics Solutions
Team members: **Jacob Battipaglia, Andrew Cecil, Krishna Gotur, and Einar Magnusson**
Advisor: **Dr. Richard Howard**

**SIXTH PLACE** ($100)
Project S20-35: Eagle Eye – Multi UAV Reconnaissance
Team members: **Kaavya Krishna-Kumar, Sagar Shah, Harmit Badyal, and Abhishek Kondila**
Advisor: **Dr. Narayan Mandayam**

**SEVENTH PLACE** ($100)
Project S20-70: Smart Sweet Spot of Your Home Stereos
Team members: **Zhenzhou (Tom) Qi**
Advisors: **Dr. Xiaoran Fan and Dr. Richard Howard**

**EIGHTH PLACE** ($100)
Project S20-45: hARk - The Next Generation Hearing Aid?
Team members: **Joshua Siegel, Aditya Verma, Shantanu Laghate, and Phurushotham Shekar**
Advisor: **Dr. Waheed Bajwa**

**NINTH PLACE** ($100)
Project S20-12: Smart Hair-Clipper
Team members: **Urmil Bhansali, Jovan Konatar, Eric Roberts, and McWilliam Mawuntu**
Advisor: **Dr. Yingying Chen**

**TENTH PLACE** ($100)
Project S20-01: Phased Patch L-Band Antenna Array
Team members: **Alexander Cid, Daniel Toth, Marissa Navarro, Cameron Greene, and Stephen Dahl**
Advisors: **Dr. Anand Sarwate, Dean Telson (L3Harris), and Alejandro Pieroni (Cellgain)**

## Capstone Special Award Winners

**BEST IN RESEARCH AWARD**
(awarded $200)
Project S20-14: Refrigerated Delivery Drone System
Team members: **Peter Doroshenko, Alex Ameri, Eric Kraut, Philip Jeszeck, and Williear Glimniene**
Advisor: **Dr. Laleh Najafizadeh**

**BEST IN IMPACT AWARD**
(awarded $200, sponsored by Interactions LLC)
Project S20-14: Refrigerated Delivery Drone System
Team members: **Peter Doroshenko, Alex Ameri, Eric Kraut, Philip Jeszeck, and Williear Glimniene**
Advisor: **Dr. Laleh Najafizadeh**

**BEST IN COMMERCIALIZATION**
(awarded $200, sponsored by JP Morgan)
Project S12-61: Agora VR: Virtual Reality Exposure Therapy of Agoraphobia & Social Anxiety Disorders
Team members: **Aryeh Ness, Daniel Nguyen, Michael Truong, and Ted Moseley**
Advisor: **Dr. Grigore Burdea**

## The Galbiati Entrepreneurial Awards

**FIRST PLACE**
(awarded $2,500)
Project S12-61: Agora VR: Virtual Reality Exposure Therapy of Agoraphobia & Social Anxiety Disorders
Team members: **Aryeh Ness, Daniel Nguyen, Michael Truong, and Ted Moseley**
Advisor: **Dr. Grigore Burdea**

**SECOND PLACE**
(awarded $1,500)
Project S20-51: Nephroto: Kidney Modeling App
Team members: **Christopher Basilio, Andrea Dumalagan, Parker Fisher, and Christian Remolado**
Advisor: **Dr. Deborah Silver**

**THIRD PLACE**
(awarded $1,000)
Project S20-56: 2020Vision
Team members: **Roshni Shah, Shruthi Sureshkrishnan, and Nithyasree Natarajan**
Advisor: **Prof. Kristin Dana**

## ECE Capstone Team Awarded 7x24 Exchange Metro New York 2020 Virtual University Challenge Grant

A shout out to our 'MediHealth Tracker' capstone team, **Rameen Masood, Purna Haque, Nga Man Cheng,** and **Holly Smith,** who represented the ECE department at the 7x24 Exchange Metro New York 2020 Virtual University Challenge for their creativity, dedication, and excellent work! You made us all proud.

Rameen Masood, Purna Haque, Nga Man Cheng, and Holly Smith are all senior year undergraduate students who developed 'MediHealth Tracker' for their capstone design project. The faculty advisor for the team is Dr. **Hana Godrich.** The team was awarded a $2,000 grant for the project. The ECE capstone program was awarded $4,000 to further invest in senior year capstone projects and research related to datacenters.

Their project tackles the issue of tracking medical records. With people constantly using different doctors and platforms controlled by their medical service providers, the objective of the team was to create a user-controlled mobile application that helps members to gain full control over their medical information in a centralized location. 'MediHealth Tracker' provides members with a private and secure environment to store and manage their health information. The app features include uploading files, storing immunizations and medication info, and an appointment manager.

The 7X24 Exchange is a leading knowledge exchange organization in the mission-critical facilities space for those who design, build, operate, and own data centers. The 7X24 Exchange Metro New York Chapter leadership has been holding a yearly University Challenge in the past five years, inviting selected tri-state area universities to participate in design challenges related to data centers. Participating teams and universities are awarded grants ranging from $1,000 to $10,000 to further advance the visibility of the data center industry to excellent students and expand capstone programs projects concentrating in this field.

# ECE Researchers receive NSF Grant for Real-Time Machine Learning in Intelligent Physical Systems

A team of ECE faculty members led by Associate Professor **Dario Pompili** (PI) has received an 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.

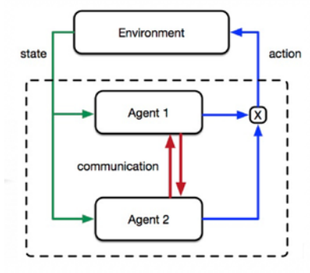
**What is being studied, what is the scope of the research?** The scope of this research project is to develop novel engineering solutions to enable real-time autonomic decision making on sparsity-aware accelerated hardware via online Machine Learning (ML) and approximation. Real-time smart decision making involves two major stages, sensing (of sensor data and then transformation into actionable knowledge) and planning (taking decisions using this knowledge). These two stages happen in both internal and external operations of an Intelligent Physical System (IPS). In case of internal operations, sensing refers to reading data from on-board sensors and planning refers to smart execution of the firmware running on the IPS. In case of external operations, sensing refers to sensing data from externally-mounted sensors and planning refers to executing the software that constitutes an application. In the sensing stage, an IPS should be able to cope with different forms of uncertainty, especially data and model uncertainties.

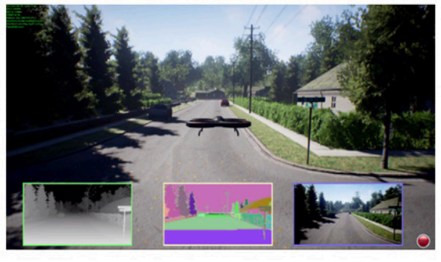
**What are the objectives of the research?** The goal of this project is to achieve the objectives of online autonomic decision making on sparsity-aware accelerated hardware via real-time ML and approximation for a group of IPSs such as drones performing data collection and/or multi-object tracking/classification and operating in a highly dynamic environment that is difficult to model. From a more technical standpoint, a real-time decision-making approach will be proposed leveraging online deep reinforcement learning with inherent distributed training capability; temporal and spatial correlation in streaming video will then be exploited towards real-time multi-object tracking/detection. Also, novel hardware architectures will be designed to support sparse Convolution Neural Networks (CNN). Considering the dual benefits of sparsity on both lower computational and space complexity for Deep Neural Network (DNN) models, a sparsity-aware

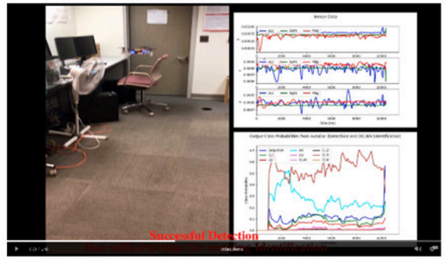
CNN accelerator can achieve significant hardware performance improvements in term of latency, throughput, and energy efficiency over non-sparsity-aware techniques. Finally, hardware-aware software engineering solutions will be studied for accelerated execution. The idea of leveraging compiler optimization and the underlying hardware features in combination will be investigate in order to optimize execution performance; then, data-driven modeling techniques will be presented to replace the time-consuming segments of the ML software packages with their equivalent data-driven models, namely micro-neural networks.

**What are the practical implications and potential benefits going forward?** Once the above research tasks are validated separately via principled experimentations in terms of their individual goals, they will be integrated into a unified framework, which will be then thoroughly studied via multiple trials on complementary field scenarios. Interestingly, the techniques under study will generalize well as they can be applied to a variety of IPS domains and of critical situations including natural calamities, man-made disasters, and terrorist attacks. For example, the proposed droned-based distributed multi-object tracking/classification solutions will enable stakeholders such as citizens, government bodies, rescue agencies, and industries to comprehend the extent of damage and the reasons for the same, and to develop more effective mitigation policies.

**How would this help our different institutions, community?** Besides conducting the research described above, we will create a new course on high-confidence ML sensing via autonomous drones (for Rutgers graduate computer engineering and undergraduate non-engineering majors); develop teaching modules for incorporation into high-school outreach activities; leverage existing minority student outreach programs and networks at Rutgers; incorporate exchange programs and team-teaching approaches; and utilize distributed education technologies.








# Pedagogical Innovations for Teaching Engineering in the Age of a Pandemic

Waheed U. Bajwa, Dario Pompili, and Narayan B. Mandayam

It would be an understatement to say that the COVID-19 global pandemic has adversely impacted the higher-education community across the US. The impact of this pandemic on the engineering education community has, in particular, been severe. Engineering education, by its very nature, is a hands-on endeavor that involves teamwork. Adapting engineering education, therefore, to the new normal of remote instructions delivered over unreliable internet connections to geographically distributed students is a challenging task. We, the faculty and staff within the Department of Electrical and Computer Engineering, faced this challenge on March 10, 2020, when the President of Rutgers University announced cancellation of in-person instructions from March 12–two days before the start of Rutgers' spring break–and asked the university faculty and staff to switch to all-remote instructions from March 23. This gave our department a total of only 12 days to plan and execute a transition to remote instructions that was the least disruptive to the learning needs of our diverse undergraduate and graduate student body. In order to fully grasp the enormity of this task, recall that while Zoom, WebEx, Microsoft Teams, and Google Meet are now household names in the US, few instructors were regular users of these videoconferencing tools at the beginning of the pandemic within the US.

The faculty andstaff within our department worked tirelessly during those 12 days to lay out the blueprints of a comprehensive and inclusive plan for remote instructions that continue to define our department's innovative approach to engineering education in the fully remote Fall 2020 semester. While implementation of this plan naturally varies from one course offering to the other, these implementations have been informed by three guiding principles of our collective plan: (1) the remote course offerings should be equitable to all students, regardless of their access to technology and their geographical location, and they should gently prod students to engage in teamwork through use of easily accessible technology; (2) the assessment components of the offerings, while remaining fair to all students, should be tailored to the remote test-taking reality, which limits the use of summative assessments for allocation of final grades; and (3) the lab components of the offerings should be reimagined to ensure students do not miss out on all-important hands-on activities that form the basis of engineering labs.

The implementation of our remote-instructions plan is a work in progress, constantly evolving effort in the face of ongoing internal discussions, evidence of impact, and student feedback. Nonetheless, we are quite pleased with the effectiveness of our remote course offerings, both in spring and in fall, in training the next generation of engineering workforce. Below, we highlight a few representative examples of the innovative pedagogical approaches our colleagues are undertaking with the help of our dedicated and hardworking staff to ensure our students continue to benefit from the world-class education that Rutgers has to offer.

### Innovations in Lecture-based Course Offerings

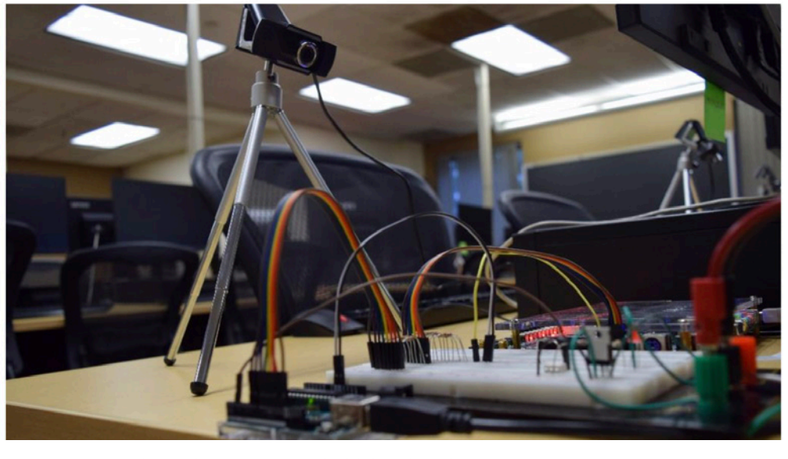
Team-based hardware projects have long been the mainstay of upper-level classes within our department. Rather than doing away with this important component of many lecture-based course offerings during this period of remote instruction, our colleagues such as Prof. Dana, who is teaching the Robotics and Computer Vision course, and Prof. Pompili, who is teaching the Wireless Communications course, are, respectively, making use of robotic simulators (e.g., Amazon RoboMaker and Gazebo) and hardware-in-the-loop drone emulators (e.g., Microsoft AirSim) to ensure students can continue to engage in team-based hardware projects.

### Innovations in Design of Assessments

Synchronously scheduled, remotely administered summative assessments, especially for large courses, in which some students might be living in different time zones, can lead to unfair evaluations of students' mastery of concepts. In order to make our offerings as equitable and fair as possible, many of our colleagues have transitioned to several formative and summative assessments, with each one accounting for only a fraction of the course grade, multiple small class design projects (with brief video presentations for each), and group-based homework assignments.

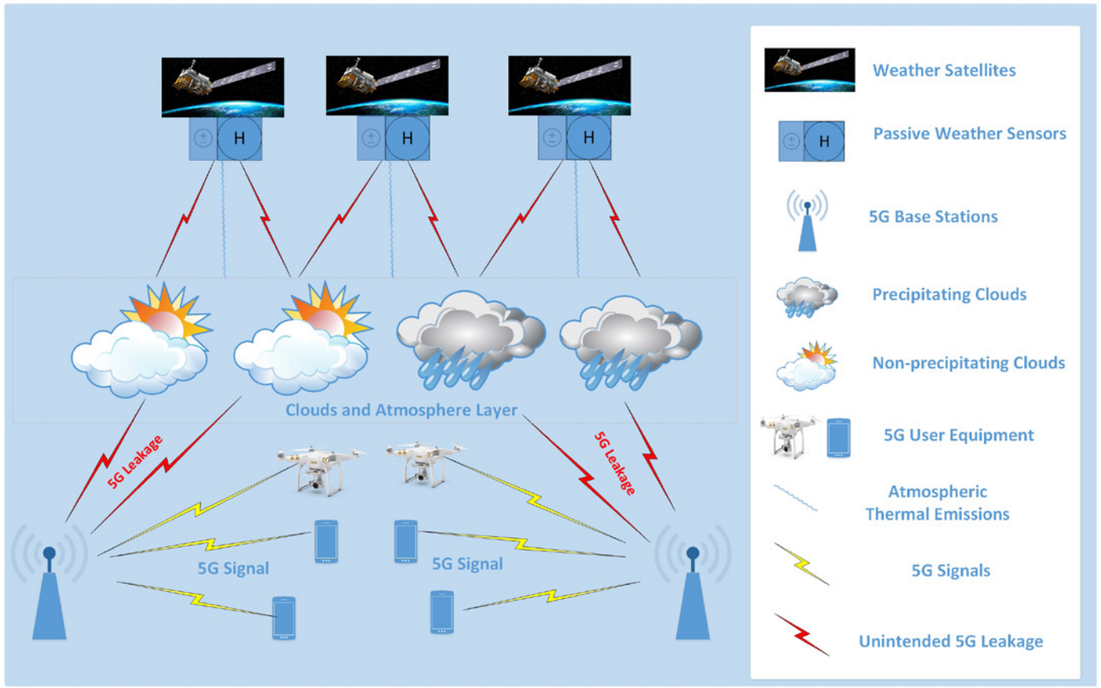
### Innovations in Lab-based Course Offerings

Hardware lab-based course offerings, which form the bulk of our lab-based offerings, present a unique challenge to instructors during this time of remote instruction. With the help of our dedicated staff, our colleagues who teach these courses have met this challenge through the use of webcams, specialized hardware, and custom-built platforms that allow students to remotely access and interact with the hardware. While such remote setups cannot replace the much-needed on-hands hardware experience for our students, they come as close to the original experience as possible in many instances.



A remote access and control setup for one of the lab-based offerings

# Rutgers study is the first to model impact of 5G radiation "leakage" on weather forecasting




Upcoming 5G wireless networks that will provide faster cell phone service may lead to inaccurate weather forecasts, according to a Rutgers study on a controversial issue that has created anxiety among meteorologists.

"Our study – the first of its kind that quantifies the effect of 5G on weather prediction error – suggests that there is an impact on the accuracy of weather forecasts," said senior author **Narayan B. Mandayam**, a Distinguished Professor at the Wireless Information Network Laboratory (WINLAB), who also chairs the Department of Electrical and Computer Engineering in the School of Engineering at Rutgers University–New Brunswick.

The peer-reviewed study was published this month at the 2020 IEEE 5G World Forum, sponsored by the Institute of Electrical and Electronics Engineers. Fifth-generation cellular wireless technology (5G) stems from new, smarter ways to use the higher (mmWave) frequencies for mobile communications. This technology will revolutionize internet communication and telecommunication. It has faster connection times, increases the number of devices that can connect to a network and will be more widely available over the next two to three years, according to IEEE.

The Rutgers study used computer modeling to examine the impact of 5G "leakage" – unintended radiation from a transmitter into an adjacent frequency band or channel – on forecasting the deadly 2008 Super Tuesday Tornado Outbreak in the South and Midwest.

The signals from the 5G frequency bands potentially could leak into the band used by weather sensors on satellites that measure the amount of water vapor in the atmosphere and affect weather forecasting and predictions. Meteorologists rely on satellites for the data needed to forecast weather.

Based on modeling, 5G leakage power of -15 to -20 decibel Watts (a decibel Watt is a unit of power that describes the strength of radio waves) affected the accuracy of forecasting of precipitation (by up to 0.9 millimeters) during the tornado outbreak and temperatures near ground level (by up to 2.34 degrees Fahrenheit).

"It can be argued that the magnitude of error found in our study is insignificant or significant, depending on whether you represent the 5G community or the meteorological community, respectively," Mandayam said. "One of our takeaways is that if we want leakage to be at levels preferred by the 5G community, we need to work on more detailed models as well as antenna technology, dynamic reallocation of spectrum resources and improved weather forecasting algorithms that can take into account 5G leakage."

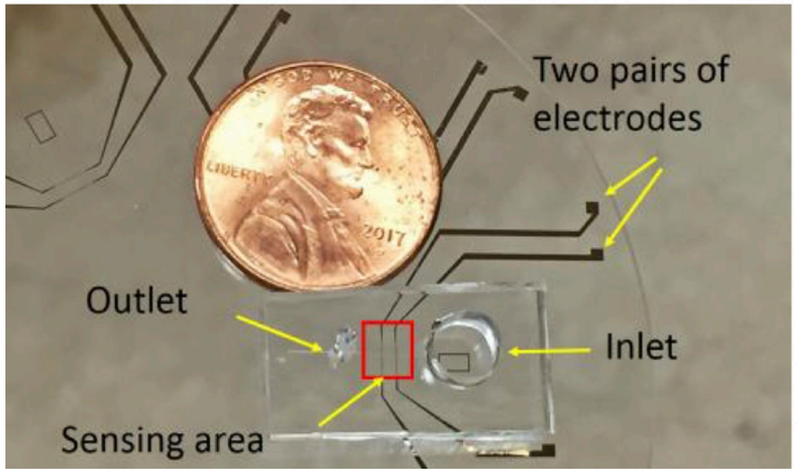
The lead author is **Mohammad Yousefvand**, a Rutgers electrical engineering doctoral student. Co-authors include Professor **Chung-Tse Michael Wu** in the Department of Electrical and Computer Engineering, Professor **Ruo-Qian (Roger) Wang** in the Department of Civil and Environmental Engineering and **Joseph Brodie,** director of atmospheric research in the Rutgers Center for Ocean Observing Leadership.





# New Portable Tool Analyzes Microbes in the Environment

Story by Todd Bates




This portable tool can rapidly reveal whether a cell is stressed, robust or unaffected by environmental conditions. Image: Jianye Sui

Imagine a device that could swiftly analyze microbes in oceans and other aquatic environments, revealing the health of these organisms – too tiny to be seen by the naked eye – and their response to threats to their ecosystems. Rutgers researchers have created just such a tool, a portable device that could be used to assess microbes, screen for antibiotic-resistant bacteria and analyze algae that live in coral reefs. Their work is published in the journal Scientific Reports.

The tool, developed initially to assess algae, can determine in the field or in laboratories how microbes and cells respond to environmental stresses, such as pollution and changes in temperature or water salinity.

"This is very important for environmental biology, given the effects of climate change and other stressors on the health of microorganisms, such as algae that form harmful blooms, in the ecosystem," 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 goal was to develop a novel way of assessing cell health that did not rely on using expensive and complex genomic tools," said co-senior author **Debashish Bhattacharya,** a distinguished professor in the Department of Biochemistry and Microbiology in the School of Environmental and Biological Sciences. "Being able to assess and understand the status of cells, without having to send samples back to the lab, can allow the identification of threatened ecosystems based on a 'stress index' for their inhabitants."

The research focused on a well-studied green microalga, Picochlorum. The tool can quickly reveal whether a cell is stressed, robust or unaffected by environmental conditions. Microbes pass one by one through a micro-channel, thinner than the diameter of a human hair. Impedance, or the amount an electrical field in the tool is perturbed when a cell passes through the channel, is measured. Impedance varies among cells in a population, reflecting their size and physiological state, both of which provide important readouts of health.

The researchers showed that electrical impedance measurements can be applied at the single-cell and population levels. The scientists plan to use the tool to screen for antibiotic resistance in different bacteria and algae that live in symbiosis with coral reefs, which will help give them a better idea of coral health.

The lead author is **Jianye Sui,** an electrical and computer engineering doctoral student at Rutgers. **Fatima Foflonker,** a graduate of the microbial biology doctoral program, co-authored the study.

## ECE Researchers win Best Paper Award at the HealthyIoT 2019 Conference

Professor **Yingying Chen** and her student **Zhenzhe Lin** have won the Best Paper Award at the 6th EAI International Conference on IoT Technologies for HealthCare (HealthyIoT 2019) for their paper titled "WiFi-enabled Automatic Eating Moment Monitoring Using Smartphones." HealthyIoT is an international scientific event series dedicated to the Internet of Things and Healthcare. HealthyIoT aims to bring together technology experts, researchers, industry and international authorities contributing towards the design, development and deployment of healthcare solutions based on IoT technologies, standards and procedures. The paper is the outcome of a collaborative effort with researchers from Indiana University & Purdue University at Indianapolis (IUPUI) and Louisiana State University (LSU).

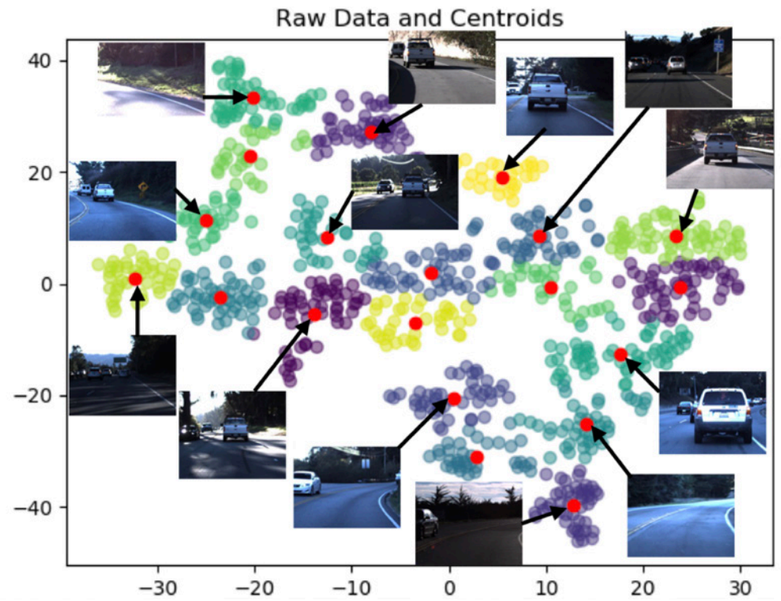
The abstract of the award-winning paper is below.

Dietary habits are closely correlated with people's health. Studies reveals that unhealthy eating habits may cause various diseases such as obesity, diabetes and anemia. To help users create good eating habits, eating moment monitoring plays a significant role. However, traditional methods mainly rely on manual self-report or wearable devices, which either require much user effort or intrusive dedicated hardware. In this work, we propose a user effort-free eating moment monitoring system by leveraging the WiFi signals extracted from the commercial off-the-shelf (COTS) smartphones. In particular, the proposed system captures the eating activities of users to determine the eating moments. It can further identify the fine-grained food intake gestures (e.g., eating with fork, knife, spoon, chopsticks and barehand) to estimate the detailed eating episode for each food intake gesture. Utilizing the dietary information, the system shows the potential to infer the food category and food amount.

# Steering Angle Prediction for Automated driving


F. Johnson

ECE Graduate student **Faith Johnson** and her advisor Prof. **Kristin Dana** have published a new algorithm for autonomous driving in the Workshop on Autonomous Driving held with IEEE CVPR 2020. Faith Johnson presented their work entitled Feudal Steering: Hierarchical Learning for Steering Angle Prediction. The work addresses the challenge of automated steering angle prediction for self-driving cars using egocentric road images. They explore the use of feudal networks, used in hierarchical reinforcement learning (HRL), to devise a vehicle agent to predict steering angles from first person, dash-cam images of the Udacity driving dataset. Faith and Prof. Dana devised a new method, Feudal Steering, is inspired by recent work in HRL consisting of a manager network and a worker network that operate on different temporal scales and have different goals. Using feudal learning to divide the task into manager and worker sub-networks provides more accurate and robust prediction (see figures).



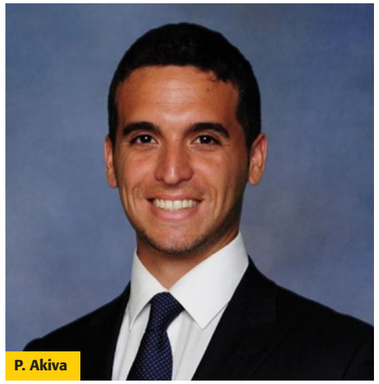
A learned dictionary of steering tasks based on video features

Examples of Steering Angle Predicition Using Dashcam video





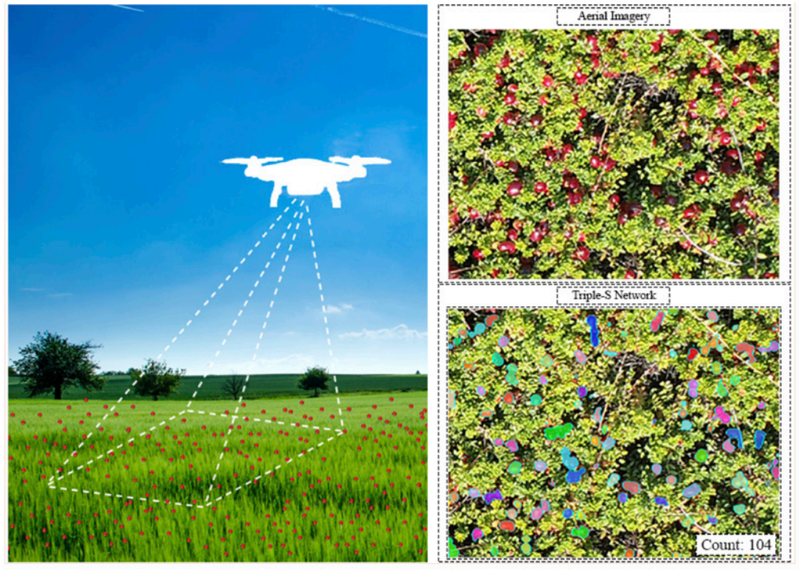
# AI on the Bog


P. Akiva


K. Dana

Prof. **Kristin Dana** of the Electrical and Computer Engineering Department and Prof. **Peter Oudemans** of the Plant Biology Department have teamed up to address the problem of Computational Agriculture with Computer Vision. Recent advances in machine learning, imaging and data science have created exciting new opportunities for applications in computational agriculture. In this proposed work, they combine computer vision with plant biology to create new, paradigm-shifting approaches for quantitatively evaluating plant health using drone imagery data they collect from 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. They have teamed with Siemens Corporate Research and received a USDA AFRI grant entitled FACT: Deep Learning for Image-based Agriculture Evaluation.

ECE Graduate student **Peri Akiva** (see figure) along with Prof. Dana, Prof. Oudemans and Michael Mars have published their work entitled Finding Berries: Segmentation and Counting of Cranberries Using Point Supervision and Shape Priors. This work was accepted at the first international workshop on Agriculture-Vision help in conjunction with IEEE CVPR 2020. Precision agriculture has become a key factor in increasing crop yields by providing essential information to decision makers. In this work, the team presents a deep learning method for simultaneous segmentation and counting of cranberries to aid in yield estimation and sun exposure predictions. Notably, supervision is done using low cost center point annotations. The approach, named Triple-S Network, incorporates a three-part loss with shape priors to promote better fitting to objects of known shape typical in agricultural scenes. To train and evaluate the network, we have collected the CRanberry Aerial Imagery Dataset (CRAID), the largest dataset of aerial drone imagery from cranberry fields (see figure)




Prof. Dana (ECE) and Prof. Oudemans (Plant Biology) along with Dave Nuns and Mike Mars for a kickoff meeting for Rutgers USDA AFRI grant entitled: FACT: Deep Learning for Image-based Agriculture Evaluation

## Irons Endowed Lectureships 2019-2020

M. Javanmard & W. Lam

**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.

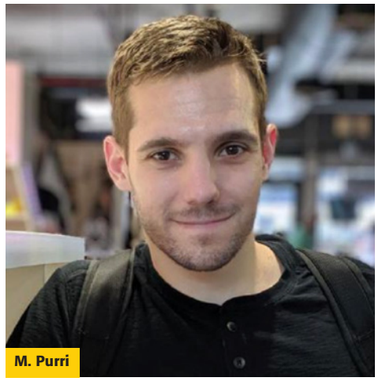
**For 2019-2020 academic year, these ECE lectures were supported by the Irons Endowed Lectureship:**

**Date:** October 30, 2019
**Speaker:** Nicholas Madamopoulos, The City College of the City University of New York (CUNY)
**Title:** Multifunctional Photonic Signal Processing Platforms for Analog and Digital Signal Processing

**Date:** February 5, 2020
**Speaker:** Alireza Nojeh, University of British Columbia
**Title:** Vacuum Nanoelectronics

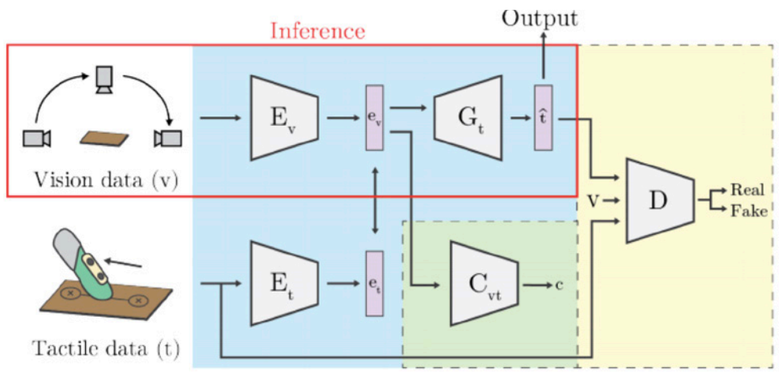
**Date:** March 11, 2020
**Speaker:** Wilbur A. Lam, MD, PhD
**Title:** Clinical Translation of Engineered Microsystems in Hematology

# Teaching Cameras to Feel



M. Purri

ECE Graduate student **Matthew Purri** and his advisor Prof. **Kristin Dana** are the authors of an accepted paper to ECCV 2020 (European Conference on Computer Vision), The title of this paper is: Teaching Cameras to Feel: Estimating Tactile Physical Properties of Surfaces From Images. The work was done under the NSF project: Seeing Surfaces: Actionable Surface Properties from Vision. The connection between visual input and tactile sensing is critical for object manipulation tasks such as grasping and pushing. This work addresses challenging task of estimating a set of tactile physical properties from visual. Matt Purri and Prof. Dana have constructed the first of its kind image-tactile dataset with over 400 multiview image sequences combined with the corresponding tactile properties as measured by SynTouch Inc. with the Toccare® Haptic Measurement System. A total of fifteen tactile physical properties across categories including friction, compliance, adhesion, texture, and thermal conductance are measured and then estimated by our models. They developed a cross-modal framework comprised of an adversarial objective and a novel visuo-tactile joint classification loss as well as a neural architecture search framework for selecting optimal combinations of viewing angles for estimating a given physical property. This work was featured in TechXplore news (https://techxplore.com/news/2020-05-tactile-properties-surfaces-images.html)




**Overview of our proposed cross-modal framework.** The model is comprised of four modules: latent space encoding (blue), joint-classification (green), adversarial learning (yellow), and viewpoint selection (not displayed). The objective of this model is to generate precise tactile properties estimates $\hat{\mathbf{t}}_i$ given vision information $v_i$. Both visual and tactile information (measured with Toccare device) are embedded into a shared latent space through separate encoder networks, $E_v$ and $E_t$. A generator function $G_t$ estimates tactile property values $\hat{\mathbf{t}}$ from the embedded visual vector $e_v$. An auxiliary classification network $C_{vt}$ generates a visuo-tactile label given $e_v$. The discriminator network D learns to predict whether a tactile-visual pair is a real or synthetic example. The modules included in the red boundary represent the networks used during inference. Note, no tactile information is used during inference.





# Zoran Gajic steps down as Graduate Director, Yingying Chen appointed new Graduate Director

Z. Gajic

Y. Chen

The Electrical and Computer Engineering Department expresses much gratitude and thanks to the outgoing Graduate Director, Professor Zoran Gajic, for his 17 years of dedicated service to the department. Zoran leaves a long-lasting legacy in the department as he has been a key player in the establishment of successful partnerships such as 3+2 programs with international University partners. He has also been a great advocate for our graduate student body and overseen many changes that led to the ECE graduate program growing to become one of the largest in the Rutgers School of Graduate Studies.

Professor Gajic, an expert in control systems, has been involved in teaching linear systems and signals, controls, communication networks, optical networks, and electrical circuit courses since 1984. He has authored/ co-authored close to 100 journal papers, primarily published in the IEEE TRANSACTIONS ON AUTOMATIC CONTROL and the IFAC Automatica journals, and eight books on linear systems and linear and bilinear control systems published by Academic Press, Prentice Hall, Marcel Dekker, Taylor and Francis, and Springer Verlag. His Prentice Hall book Linear Dynamic Systems and Signals was translated into the Chinese Simplified Language by Jiaotong University Press in 2004. His 1995 Academic Press book Lyapunov Matrix Equation in Systems Stability and Control was republished in 2008 by Dover Publications. He has supervised 16 doctoral dissertations and 22 master theses. Ten of his former doctoral students hold faculty positions with respected world universities. His research interests are in controls systems, energy systems, such as fuel and solar cells, wind, and smart grids, wireless communications, and networking. He is a Life Senior Master of the U.S. Chess Federation and a Master of the World Chess Federation. He has delivered four plenary lectures at international conferences and presented close to 150 conference papers. He has served on editorial boards for nine journals and as a guest editor for five journal special issues.

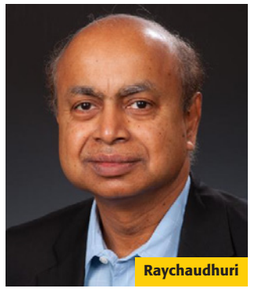
Yingying Chen will serve as the ECE Graduate Director. Yingying has been an outstanding contributor to the department's mission as Associate Undergraduate Director while leading an extremely successful and highly visible research program and also playing an important leadership role at WINLAB. Professor Chen has stepped up to take on this increasingly challenging role in our department as we navigate these uncertain times.

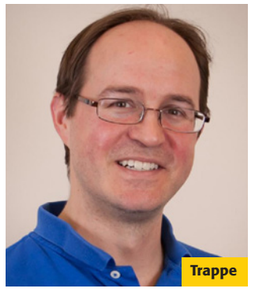
Professor Chen also serves as an Associate Director of Wireless Information Network Laboratory (WINLAB). She leads the Data Analysis and Information Security (DAISY) research group. Her research interests include smart healthcare, cyber security and privacy, Internet of Things, and mobile computing and sensing. She has coauthored three books, published more than 150 journals and referred conference papers and obtained 8 patents. Her background is a combination of Computer Science, Computer Engineering and Physics. Prior to joining Rutgers, she was a tenured professor at Stevens Institute of Technology and had extensive industry experiences at Nokia (previously Alcatel-Lucent). She is the recipient of the NSF CAREER Award and Google Faculty Research Award. She also received NJ Inventors Hall of Fame Innovator Award. She is the recipient of multiple Best Paper Awards from IEEE CNS 2018, IEEE SECON 2017, ACM AsiaCCS 2016, IEEE CNS 2014, and ACM MobiCom 2011.

# WINLAB

## Three WINLAB Teams receive Planning Grants for NSF SII Spectrum Center Initiative


Mandayam


Raychaudhuri


Trappe

Three WINLAB teams receive Planning Grants for the NSF Spectrum Innovation Initiative (SII), which is a recently announced program at NSF that includes funding for a planned $25M/5yrs research center with full proposals due in March 2021. The description of these initiatives is provided below.

**WINLAB Team led by Professor Mandayam**

A team of Rutgers researchers is part of a multi-university initiative that has been awarded a $300K/1yr Spectrum Innovation Initiative (SII) Planning Grant from the NSF. The other universities in this collaborative effort are Virginia Tech, University of Southern California, University of Colorado-Denver, Stevens Institute of Technology, University of California Irvine, Princeton University, and North Carolina State University. This Rutgers team is led by Distinguished Professor **Narayan Mandayam** (PI). The Co-PIs from Rutgers include ECE Assistant Professors **Chung-Tse Michael Wu** and **Jorge Ortiz,** CEE Assistant Professor **Ruo-Qian (Roger) Wang,** and Dr. **Joseph (Joe) Brodie** from Atmospheric Research. This planning grant initiates concerted activities for research, education, and community engagement as a stepping stone towards ARIES: A proposed center for versatile, agile, reliable, and scalable spectrum, through a fundamentally novel framework guided by two principles: (a) A reductionist and integrative approach to spectrum research that can identify foundational (domain-agnostic) problems and then integrate them with domain-specific knowledge; and (b) A set of key spectrum attributes (agility, reliability, scalability, and versatility) that serve as a unified framework for quantifying the technical, policy, and social requirements of diverse stakeholders.

**WINLAB Team led by Professor Raychaudhuri**

The NSF has awarded a $300K/1yr SII Planning Grant to a multi-university team led by Distinguished **Professor Raychaudhuri** (PI) and **Ivan Seskar** (Co-PI) of Rutgers ECE/WINLAB. This proposal is aimed at the development of a comprehensive plan for an exceptional SII Center which would help maintain and extend US leadership in future wireless technologies, systems, and applications in science and engineering through the efficient use and sharing of radio spectrum. The team that has been assembled for this SII planning proposal spans eight universities (Rutgers, Columbia, NYU, U. Arizona, UT Austin, Oregon State, Princeton, and U. Wisconsin-Madison) and consists of well-established wireless researchers with prior contributions to spectrum across a range of specializations. The PIs propose to work together over the next 9-12 months to develop a compelling research agenda, round out the team's expertise and diversity, conduct pilot studies to obtain preliminary results on key topics (TeraHz, passive spectrum users, and dynamic spectrum access), engage extensively with research, government, and industry stakeholders, and develop plans for experimental infrastructure and education/ workforce development.

**WINLAB Team led by Professor Trappe**

A team of Rutgers researchers is part of a multi-university initiative that has been awarded a $300K/1yr SII Planning Grant from the NSF. The other universities in this collaborative effort are Virginia Tech, CMU, University of Florida, MIT, Purdue University, UT Austin and University of Washington.The Rutgers team is led by Professor **Wade Trappe** (PI). The Co-PIs from Rutgers include ECE Professor **Yingying Chen** and Physics and Astronomy Professor **Andrew Baker.** This award is forplanning activities for an envisioned center with three primary research activities aligned with national priorities: (1) increase of spectrum efficiency and agility; (2) enabling near real-time spectrum awareness and automated spectrum decision making; and (3) enforcement and security, passive use protection, and safety of radio frequency emissions. The team will carry out and promote research associated with spectrum flexibility and agility that will enable the use of multiple spectral bands, and novel multi-functional waveforms. They will carry out and promote research that provides the ability to manage and access spectrum at a high-level of fidelity and fine granularity while maximizing automation. And they will carry out and promote research that advances the state-of-the-art in spectrum rule enforcement and incumbent user protection, with a particular focus on protecting passive users of spectrum.

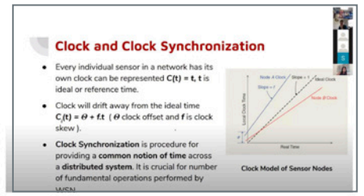
## WINLAB Researchers win Best Paper Award at the 2019 IEEE Wireless Communications and Networking Conference

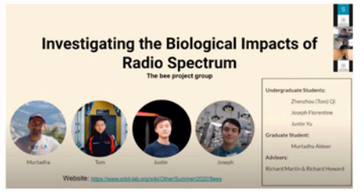
Professor **Wade Trappe** and Research Scientist **Andrey Garnaev** have won the Best Paper Award at the 2019 IEEE Wireless Communications and Networking Conference (IEEE WCNC) for their paper, "An Eavesdropping and Jamming Dilemma when the Adversary might be Subjective." IEEE WCNCis the world premier wireless event that brings together industry professionals, academics, and individuals from government agencies and other institutions to exchange information and ideas on the advancement of wireless communications and networking technology.The abstract for the award winning paper is below.Wireless networks are susceptible to malicious attacks, especially those involving jamming and eavesdropping. To maintain secure and reliable communication under such threats, different anti-adversary strategies have been proposed to mitigate the adversary impact. In this paper, we consider a sophisticated adversary with the dual capability of either eavesdropping passively or jamming any ongoing transmission, and investigate a new aspect to consider when designing an anti-adversary strategy: how uncertainty about whether the rival is rational or subjective could impact the strategies. To model such uncertainty, we formulate a Bayesian Prospect Theory (BPT) extension of the game between a user and an adversary who chooses between an eavesdropping attack and a jamming attack against the user. Meanwhile the user chooses against which of the threats to apply the corresponding best response strategy. Uniqueness of the BPT equilibrium strategies is proven and they are found in closed form.





# 2020 WINLAB Summer Internship Program





On Thursday, July 30th, WINLAB concluded its first ever fully virtual Summer Research Program. The program took place over eight weeks during the months of June and July, and included 32 students (24 undergraduate, 6 graduate, and 2 high school) who collaborated on projects in topics including machine learning, IoT, and spectrum sensing. As with many summer programs at Rutgers this year, the students were unable to meet in person or visit any Rutgers facilities; all communication for the internship program (including with project supervisors and WINLAB staff) was conducted virtually. The remote nature of the program also relied heavily on WINLAB's extensive capabilities as a remote testbed facility; the interns had access to all of the computing and wireless resources of the lab that they would have had in person. The internship culminated in a virtual open house held over Zoom during which the interns presented their final projects to their families and each other. Despite tempered expectations due to the difficulties of a remote internship, there was lots of positive feedback from everyone involved. "I was quite skeptical of how this was going to end up given that we are doing everything remotely," said WINLAB Chief Technologist **Ivan Seskar,**" and I have to admit that I was completely wrong; it actually turned out to be quite successful." Machine learning featured heavily in many of the projects this year. Returning intern **Michael Yakubov** said this about his experience: "My partner and I made a machine learning model and worked on making it suitable for an FPGA. The remote WINLAB experience was very enjoyable and convenient. Since my project was entirely programming based, I could very easily do it remotely, and I could remotely connect to the ORBIT/COSMOS system at WINLAB whenever necessary. The weekly presentations and mentor meetings were also very well coordinated, and good replacement for in person presentations under social distancing requirements. I liked that I could work on my project at any time, as sometimes I wanted to work on my project on weekends, or I would get an idea for my project late at night, and I could easily get on my computer and work on the project right away." Several other groups continued the development of the smart city/self-driving car project from previous internships. One group worked on developing a simulation of a self-driving car model in lieu of working with the physical hardware available at the lab. The simulated self-driving model was designed to work in conjunction with the Intersection Simulation project–a fully virtual model of the miniature city built at WINLAB by students in previous internships. This group also worked on adding more activity to their virtual city using a traffic simulator. One of the next steps for this project is to integrate the output of another internship project, the Smart Intersection, which designed a system to identify and monitor traffic in a real-world intersection." This summer I was fortunate enough to work on a team and design a system which tracked vehicle flow through an intersection," said **Nicholas Meegan** about his experience with WINLAB. "Although we were unable to meet in person over the course of the internship, each week we were able to still come together and discuss next steps as well as present our research through Google Meet. Working remotely also meant that we were able to connect and use the state-of-the-art WINLAB computing system from home, allowing us to have powerful tools at our disposal and truly make our projects successful. All in all, despite the inability to meet and work in person, the remote WINLAB internship granted me a fantastic experience and a skillset that will be invaluable in future endeavors."

Many of the interns mentioned how much they appreciated the exposure to real-world problems and the opportunity to develop new skills and work with new technology." I got to learn a new coding language I hadn't known before and practice my communication skills every week. I had meetings multiple times in a week with my group where we got to learn new things and work together to tackle problems and obstacles together though everything was remote. ... It was an amazing experience which I would highly recommend to everyone." said **Saurahb Bansal,** who worked on a project which used adversarial machine learning to attack voice assistant systems. **Milos Seskar,** who worked on the Machine Learning Acceleration with FPGAs project, said this: "I highly recommend WINLAB for students interested in exploring the latest research topics in engineering, mathematics, and computer science." Even though the internship is over, many of the projects are not; several students have elected to continue working on their projects during the fall semester. Everyone involved shares the sentiments expressed by Ivan at the conclusion of the open house: "I hope we will be able to meet in person some time in the future–hopefully not too distant future."

## WINLAB Researchers receive NSF Grant for Hardware-accelerated Trustworthy Deep Learning

ECE Professor **Yingying Chen** (PI) and WINLAB CTO, **Ivan Seskar** are the recipients of a new NSF planning award titled "Hardware-accelerated Trustworthy Deep Neural Network" from the NSF Principles and Practice of Scalable Systems (PPoSS) program. This is a one-year $250,000 collaborative effort among Rutgers, Indiana University, Temple University and NYIT, covering the disciplines of electrical and computer engineering, computer science, security and data science. The aim of the PPoSS program is to support a community of researchers who will work symbiotically across the multiple disciplines above to perform basic research on the scalability of modern applications, systems, and toolchains. The planning grant will be used to develop a LARGE grant proposal to foster the development of principles that lead to rigorous and reproducible artifacts for the design and implementation of large-scale systems and applications across the full hardware/software stack.During the planning phase, Yingying's team will develop a scalable and robust heterogeneous system that includes a new low-cost, secure, deep-learning hardware accelerator architecture and a suite of large data compatible deep learning algorithms. The new technologies resulting from this planning grant will also enable extremely large-scale data and facilitate efficient,low-latency applications in connected vehicles, real-time mobile applications, and timely precision health.


S. Jha

## Shantenu Jha Promoted to Professor with Tenure

The ECE Department is proud to announce that the Board of Governors has approved Dr. **Shantenu Jha**'s promotion to Professor with tenure effective July 1, 2020. Congratulations on this well deserved accomplishment Shantenu!


S. El Rouayheb

## Salim El Rouayheb Promoted to Associate Professor with Tenure

The Board of Governors has approved Dr. **Salim El Rouayheb**'s promotion to Associate Professor with tenure effective July 1, 2020. Congratulations on this well deserved accomplishment Salim!


A. Sarwate

## Anand Sarwate Promoted to Associate Professor with Tenure

The Board of Governors has approved Dr. **Anand Sarwate**'s promotion to Associate Professor with tenure effective July 1, 2020. Congratulations on this well deserved accomplishment Anand!

## Anand D. Sarwate Awarded Board of Trustees Research Fellowship for Scholarly Excellence

**Anand D. Sarwate**, a professor in the School of Engineering's Department of Electrical and Computer Engineering, recently received a Board of Trustees Research Fellowship for Scholarly Excellence. The prestigious award recognizes Sarwate's achievements as one of the university's most outstanding young faculty members.

"Receiving this award is a great honor and was a total surprise since I didn't know I'd been nominated," Sarwate says. "It makes me feel like I've been doing something of value to Rutgers, instead of just to my subspecialty, and that it's supporting the sum total of my efforts."

Sarwate, who has been promoted to associate professor effective July 1, joined the School of Engineering faculty in January 2014. He is a 2015 recipient of the prestigious National Science Foundation Early Career Development Award (CAREER) for his research on privacy-preserving learning for distributed data that uses practical algorithms to bridge the gap between the theoretical and actual preservation of privacy.

His ongoing research interests include privacy-preserving data analysis, machine learning and statistics, information theory, and distributed optimization and signal processing.

According to Sarwate, the financial support from the fellowship will help him and the students whose research he supervises in the coming academic year. "Perhaps construed more broadly, a recognition like this helps me remember that research is a long-term endeavor, so that I can focus on projects which may be slow to get off the ground, but which will ultimately make an impact," he explains.

With this award, Sarwate joins a select group of Rutgers University faculty members distinguished by their exceptional scholarly contributions and achievements. "While I'm doing the research work because it interests me, this award makes me feel connected to the rest of the University," Sarwate adds.



# Metamaterial-Based Radar Sensors for Multi-Target Vital Sign Detection and Location Tracking

**Conventional Radar Sensor Module for Vital Sign Detection and Location Tracking: Homodyne Architecture**

Doppler radar sensors have been widely developed for healthcare monitoring techniques in the past decades, such as vital sign detection and see-through-wall physiological monitoring, with a growing demand particularly due to increasing elderly population worldwide. Compared with other conventional cardiac monitoring devices, such as finger pulse oximeter or electrocardiography, radar sensors can achieve contactless and noninvasive vital sign detection thanks to the characteristics of electromagnetic (EM) waves.

One of the most commonly used architectures for vital sign detection is based on a homodyne transceiver, where a transmitting antenna (Tx) sends an interrogating radiofrequency (RF) signal towards the target, whereas the reflected signal scattered from the target is captured by a receiving antenna (Rx), and then down-converted to in-phase and quadrature (I/Q) baseband signals by a RF mixer. Due to the target motion and chest movements, the distance between the target and radar sensor varies over time. As such, the reflected signal is modulated by the well-known Doppler effect, where vital sign and distance information can be extracted. Based on the homodyne architecture, conventional Doppler radar sensors are usually used to detect single target at a time. To achieve multi-target detection, efforts have been made previously by the microwave community. For instance, mechanical rotors, phased antenna arrays or digital beamforming, can be incorporated in radar sensors to achieve beam-steering capability. Nevertheless, these topologies usually entail large system size, e.g., for mechanical rotors, high cost and complexity due to additional controlling schemes or algorithm, e.g., for phased arrays and digital beamforming.

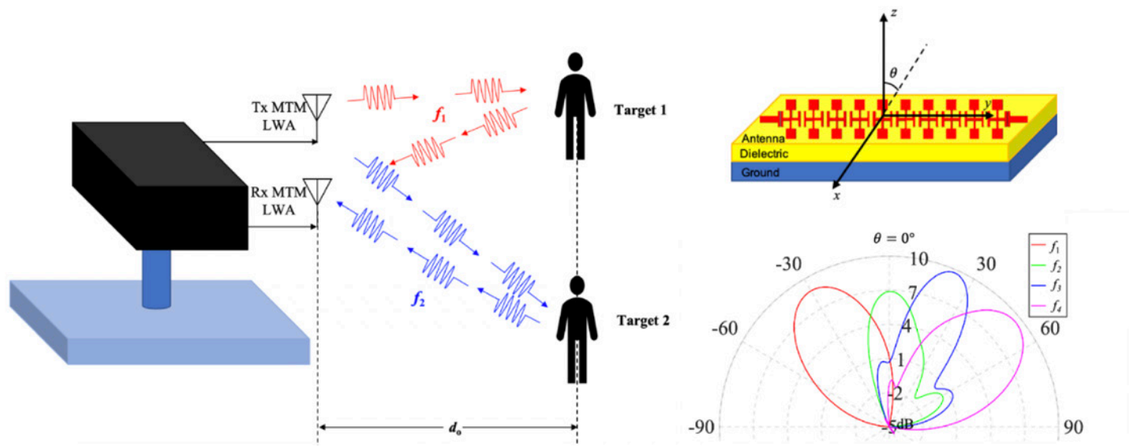
**Metamaterial (MTM) Leaky Wave Antenna (LWA)-Based Radar Sensor for Multi-Target Vital Sign and Motion Detection**

To overcome the aforementioned issues, metamaterial (MTM) leaky wave antennas (LWA) are utilized as a remedy to detect multiple targets. MTM is an artificial structure with unusual properties, such as negative index of refraction, which cannot be found in nature. The idea of MTM is first proposed by Viktor Veselago in 1967, where he theoretically predicted the existence of left-handed (LH) materials. In 2002, it was proposed by several research groups to realize EM MTMs using transmission line (TL) approaches. Furthermore, when operating in the fast wave region, MTM LWAs have been demonstrated to exhibit frequency-dependent beam steering capability with a large scanning angle from backfire-to-endfire direction.

By manipulating such frequency-dependent beam scanning characteristics, Dr. **Chung-Tse "Michael" Wu** along and his PhD student **Yichao Yuan** have first developed an MTM LWA structure operating at the 24 GHz band to detect vital sign signals and track motion for multiple targets at different locations without additional tunning mechanisms, leading to a reduced system size as well as to lower cost and complexity.

**MTM LWA-Based Self-Injection Locked (SIL) Radar Sensor**

In addition to the conventional radar sensor architecture, Dr. Wu's group proposed a new architecture using self-injection locked (SIL) radar sensor integrated with MTMs to detect vital sign signals and track the location for multiple people at the same time. In this scenario, an MTM LWA is employed to transmit the interrogating RF signal coming from a self-injection locked oscillator (SILO), and also receive the reflected signal modulated by the target, which will then in turn be coupled into the oscillator and modify the oscillation frequency. In other words, the output frequency of SILO will be injection-locked to a new one. Since the reflected signal is related to cardiopulmonary activities, vital sign information can be obtained from the output signal of the SILO. As such, the resulting MTM SIL radar sensor can detect vital sign signals and locations for multiple targets concurrently with a high sensitivity as well as low system complexity compared with conventional radar sensor architectures.



## Rutgers Researchers receive DARPA Grant for Development of Smart Bandages


M. Javanamard

ECE Associate Professor **Mehdi Javanmard** (Co-PI) is part of a Rutgers/Princeton team of researchers that received an award from Defense Advanced Research Projects Agency (DARPA) for the project entitled "Modular Platform for Dynamic Biochemical Sensing of Acute Skin Wounds." This one-year, $455,649 seedling grant project aims to develop smart bandages for wound healing and is a collaborative effort with Rutgers researchers, Professor **Francois Berthiaume** (PI) from BME and Associate Professor **Aaron Mazzeo** (Co-PI) from MAE.

## ECE Researchers receive NSF Grant to Develop a Multi-modal Biosensing Platform


U. Hassan

A team of ECE faculty members led by Assistant Professor **Umer Hassan** (PI) have received a new NSF award for the project titled " Multi-Modal Data-Driven Platform for Multiplexed Cellular Antigen Classification using Nano-electronic Barcoded Particles for Whole Blood Applications."

This project includes Associate Professor **Mehdi Javanmard** as a co-PI. The total award amount for this three-year project is $500,000. The project seeks to develop the next generation biosensing platform equipped with multi-modal sensing and novel nano-barcoded particles to perform reconfigurable biomarker selection in whole blood samples. Human blood cells play a critical role in immune system activation in response to infections. Concentration of these immune cells in whole blood and their membrane receptor densities may change in different diseases and their pathogenesis. The heterogeneity of the cellular classification needs to be quantified to provide a personalized diagnostics and patient monitoring system in hospital settings. The biosensing platform will be integrated with multi-modal sensing including electrical and optical which will allow to correct for inherent device-device variation to improve the sensor performance. Immune cells conjugated with functionalized nano-barcoded particles will be quantified in sync by impedance detector and smartphone attachment. Further, the proposed biosensor will be equipped with real-time data analysis using machine learning to enable a reconfigurable system for resource optimization and biomarker selection. The proposed sensor will enable multiplexed cellular antigen classification from a drop of whole blood with time to result (TOR) of less than 30 minutes. Sensors will be benchmarked with patient samples collected from the Robert Wood Johnson Medical Hospital. This cross disciplinary project will train undergraduate and graduate students in areas of sensors, systems and bionanotechnology.

## Mehdi Javanmard Wins DARPA Young Faculty Award

ECE Associate Professor **Mehdi Javanmard** has received the DARPA Young Faculty Award (YFA) for the project titled "Lab-on-a-Microparticle: Injectable Wirelessly Powered Label-free Nanowell Sensors for In Vivo Quantification of Protein and Small Molecules." The objective of the DARPA YFA program is to identify and engage rising stars in junior research positions, and to expose them to DoD needs and DARPA's program development process. The YFA program provides funding, mentoring, 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. Mehdi has also been recognized previously with an NSF CAREER Award. This most recent DARPA YFA is the second such award in successive years in the ECE department (along with 8 active NSF CAREER Awards), reflecting the phenomenal successes of our young faculty members!

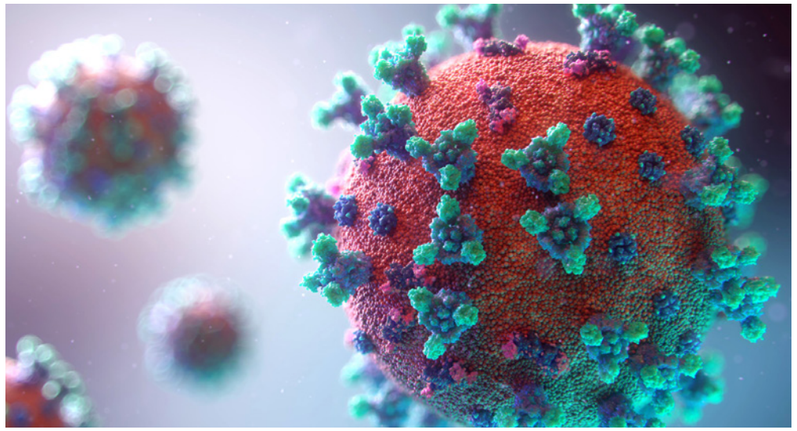
## Umer Hassan receives DURIP Award for Combatting Decompression Illness in Undersea Missions

Assistant Professor **Umer Hassan** has received a Defense University Research Instrumentation Program (DURIP) Award for his project titled "MEDIUM: Monitoring and Engineering Decompression Illness during Undersea Missions." The DURIP instrumentation awards provide the unique means through which the Depart of Defense supports universities in the acquisition of essential laboratory equipment, usually out of reach for most research grants. As part of this project, Dr. Hassan has received a $84,625 award from the Office of Naval Research (ONR) to build the MEDIUM platform for personalized testing, monitoring and engineering divers' innate ability to prevent decompression illness, one of the most prevalent medical conditions experienced by the divers during underwater diving missions. Current diagnosis is highly non-specific and relies on symptoms such as joint pains, paralysis, fatigue, memory loss, and shortness of breath. Decompression usually results in a blocked blood vessel caused by air or gas bubbles and subsequently triggers the divers' immunological response. It's a highly individualized condition with patients experiencing different levels of severity and can potentially lead to shock and patients' mortality. The challenges include stratifying a highly individualized condition with heterogeneity in divers' immune response to the presence of bubbles and strategizing the personalized therapeutic drugs. The MEDIUM platform will be instrumental in performing experiments to address the above challenges.





# Fighting COVID-19 with Technology



If innovation is born of necessity, today's COVID-19 crisis poses urgent opportunities. As scientists and engineers desperately search for ways to address the devastating impacts of the virus, many are taking a second look at their existing research to see how it might be applied to treatment, testing, and prevention.

**Umer Hassan,** an assistant professor of electrical and computer engineering at Rutgers School of Engineering, is committed to saving lives by waging war against pressing global health problems. And for Hassan, defeating the coronavirus has become an urgent research priority and a natural extension of his existing research.

Hassan, who also holds a joint appointment as a core faculty member at Rutgers Global Health Institute, has developed a sensor that can quantify the ability of human white blood cells to kill bacterial pathogens.

"We are processing only a drop of blood sample on a sensor chip," he says. "Rather than using actual bacteria, we are testing with biofunctionalized microspheres to measure the phagocytic response of leukocytes."

Now he is hoping to apply similar technology to the fight against COVID-19. "It will be interesting to see if a sensor can be employed to stratify high risk coronavirus patients – to see if white blood cells can effectively kill the virus," says Hassan, who hopes to receive funding for this project. If his hunch is right, it could lead to therapeutic innovations.

Such exploration is a natural extension of Hassan's recent work in developing an inexpensive automated biosensor device that even minimally trained health care providers can use to diagnose sepsis – an infection that is responsible for as many as six million largely preventable deaths a year*.

Hassan is rising to the challenge of developing a diagnostic sensor to help combat the coronavirus' spread. "We're still learning about the COVID-19 virus. There's a strong possibility that it will mutate – just as influenza viruses mutate into different strains each year – before a vaccine is developed," he explains.

The likelihood of mutations intensifies Hassan's determination to develop a rapid, easy-to-use widespread screening test. "The only reason COVID-19 has become a global outbreak is because of the lack of a screening test at points of entry across the globe," he says. "Initially, people's temperatures were taken to check for fevers. Now we are learning that this isn't a reliable test, as many infected people have no symptoms and no fever. Relying on temperature screening alone helped spread the virus very quickly." Looking ahead, he anticipates that developing a reliable sensor for screening and identifying those infected with the coronavirus could very well become a primary research goal.

Another of Hassan's research projects has promising implications for the COVID-19 fight. "We have synthesized eco-friendly silver nanoparticles from plant extracts that are just as toxic to bacterial pathogens such as E. coli or certain strains of staphylococcus as hazardous chemicals." While he has yet to test the silver nanoparticles on the coronavirus, he has submitted a grant proposal to do this.

Hassan additionally hopes to embed these eco-friendly silver nanoparticles in surgical masks. As the mask wearer inhales, airborne pathogens would be filtered into the mask and killed by the silver nanoparticles. "This is a next-generation mask that would solve a major problem for those wearing masks for a long time," says Hassan. "Currently, as masks capture particles over time, the mask itself becomes highly biohazardous." It is a potentially elegant solution to issues raised by the COVID-19 pandemic's shortage of efficacious PPE.

Hassan is in close contact with the Rutgers Office of Research Commercialization and exploring ways to rapidly translate these technologies into different health-care settings.

*World Health Organization, April 2019

## COSM-IC grant awarded to Rutgers, Columbia, U Arizona, and CCNY


I. Seskar

A Rutgers / Columbia / U Arizona / CCNY team has been awarded a $3M/3yr grant (Rutgers amount $840K) from NSF entitled "IRNC: Testbed: COSMOS Interconnecting Continents (COSM-IC)". The Rutgers PI is WINLAB Chief Technology Officer **Ivan Seskar,** with Distinguished Professor **Dipankar Raychaudhuri** as Co-PI. The project is aimed at development of an international networking and wireless testbed by federating US research testbeds including COSMOS, ORBIT, FABRIC and PEERING with experimental facilities in Ireland, Greece, Brazil, and Japan. The federated international testbed will enable experimental research on a wide range of optical, wireless, SDN networking, inter-domain routing, and edge computing experiments at a global scale.

## Bo Yuan receives NSF Grant for Advancing On-Device Inference and Learning in Deep Neural Networks


B. Yuan

ECE Assistant Professor **Bo Yuan** is the recipient of a new NSF award for the research project titled "TensorNN: An Algorithm and Hardware Co-design Framework for On-device Deep Neural Network Learning using Low-rank Tensors." Dr. Yuan is the lead PI on a three-year $1.2 million collaborative effort between Rutgers, Columbia University, and University of Minnesota.

In this project, Dr. Yuan and his team aim to advance efficient on-device inference and learning for deep neural networks (DNNs). In order to achieve stronger data privacy, less response time and relaxed data transmission burden, deploying DNN functionality in a distributed manner at the edges of the network has become a very attractive proposition. However, DNN-learning on mobile devices that are at the edge of the network is very challenging due to conflicting requirements of large time and energy consumption, and limited on-device resources. In order to address this challenge, this project leverages low-rank tensors as a powerful mathematical tool for representing and compressing tensor-format data, to form a new family of ultra-low cost deep neural networks. This brings an order-of-magnitude reduction in time and energy consumption for deep neural network learning. Investigations in many areas of BigData research will benefit as well. This project involves graduate and undergraduate students, especially from underrepresented groups, through summer research experiences, and senior design projects to broaden the participation of computing. The outcomes of this project will be disseminated to the community in the format of technical publications, talks and tutorials in both academic institutions and industry.

## Emina Soljanin receives NSF Grant for Advancing Quantum Key Distribution


E. Soljanin

ECE Professor **Emina Soljanin** is the recipient of a new NSF award for the research project titled "Towards Full Photon Utilization by Adaptive Modulation and Coding on Quantum Links." This is a two-year $500,000 collaborative effort between Rutgers and UCLA.

In this project, Dr. Soljanin and her team advance secure quantum communications. Secure communication has long been an indispensable part of numerous systems, ranging from the more traditional such as finance and defense to the emerging ones such as the Internet of (battlefield) Things and health data management. The main advantage of private key encryption over the currently popular methods is that, as long as the key bits are truly secret, it is provably secure; that is, insensitive to advances in classical and quantum computing algorithms. A Quantum Key Distribution (QKD) protocol describes how two parties, commonly referred to as Alice and Bob, can establish a secret key by communicating over a quantum and a public classical channel when both channels can be accessed by an eavesdropper Eve. For the widespread adoption of QKD, it is mandatory to provide high key rates over long distances. What has emerged as a bottleneck in practice is the inability to maximize the utility of information-bearing quantum states. This project seeks to solve this inefficiency problem for frequency-time entanglement based QKD. The results will pave the way for practical quantum networks in which multiple Bobs communicate with Alice simultaneously though a multi-channel entanglement distribution in the presence of multiple Eves.

## Laleh Najafizadeh receives Provost's Award for Excellence in Cross-Disciplinary Research

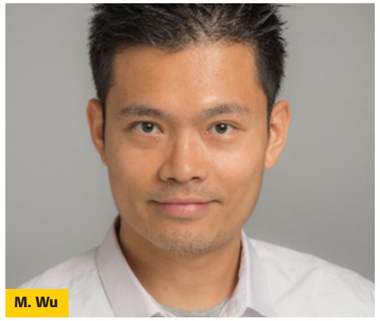

L. Najafizadeh

ECE Associate Professor **Laleh Najafizadeh** has been chosen to receive the 2019-20 Provost's Award for Excellence in Cross-Disciplinary Research. This award honors individual faculty (Assistant or Associate Professors, tenure-track or non-tenure track) whose research area aims to achieve disruptive or transformative impacts at the interface of two disparate fields of scholarship or inquiry. Dr. Najafizadeh has an established record of outstanding multidisciplinary research at the intersection of engineering and neuroscience. She conducts fundamental research to develop novel computational methods for analyzing neuroimaging data obtained through invasive and non-invasive imaging modalities. These methods have led to better scientific understanding of the neural mechanisms underlying behavior, learning, and plasticity, and have promising applications in next-generation brain computer interfaces (BCIs), psychology, personalized rehabilitation, and clinical neuroscience. The impact of her research is evident through successful collaborations across Rutgers with the Departments of Psychology, Cell Biology and Neuroscience, and Biomedical Engineering. She and her team have introduced computational methods to extract temporal features from calcium imaging data, demonstrating for the first time, that the temporal characteristics of calcium transients can be utilized to decode behavior. In other work, she and her students have developed a novel data-driven segmentation technique for EEG recordings, which has been adopted by researchers in the Department of Psychology to study and understand how the human brain makes decisions about time. She and her team have also developed new frameworks for studying the dynamics of the brain that have significantly improved BCI performance. This honor given to only two faculty members selected from across all of Rutgers University, carries an institutional award of $5,000 and will be presented to Dr. Najafizadeh at the Chancellor's Celebration of Faculty Excellence, on Tuesday, March 24, 2020.





## ECE Researchers receive NSF Grant for Design of Secure IoT Devices


M. Wu

A team of ECE faculty members led by Assistant Professor **Chung-Tse Michael Wu** (PI) has received an Early Concept Grant for Exploratory Research (EAGER) award from the NSF for the project titled "Directional Modulation Non-Contiguous OFDM Retrodirective Communication for Secure IoT." This project includes Associate Professor **Waheed Bajwa** and Distinguished Professor **Narayan Mandayam** as Co-PIs. The total award amount for this two-year project is $300,000.

This project aims to address a critical security issue in IoT applications that are susceptible to malicious spoofing attacks via an innovative PHY solution combining Non-Contiguous Orthogonal Frequency Division Multiplexing (NC-OFDM) transmission and a directional modulation retrodirective array. As compared with traditional OFDM transmissions, NC-OFDM transmissions take place over a subset of active subcarriers to either avoid incumbent transmissions or for strategic considerations. On the other hand, retrodirective antenna arrays are well known to be able to respond to the interrogator by sending a signal back to the interrogator location without a priori knowledge, which is particularly useful in a multipath-rich environment. One way to realize the directional modulation functionality is to use time-modulated antenna arrays, in which the aliasing effects resulting from the time-modulation frequency are used to distort the signals in the undesired directions. Furthermore, the project will establish that the unique integration of NC-OFDM and directional modulation enabled by a time-modulated retrodirective antenna array whose modulation frequency is the NC-OFDM subcarrier can potentially lead to an unprecedented level of PHY hardware security against spoofing attacks by an adversary, even when the adversary is equipped with sophisticated Machine Learning based attack techniques.

## ECE Researchers win Best Paper Award at the 2020 ACM Multimedia Systems Conference (MMSys)


S. Wei

A team of researchers led by ECE Assistant Professor **Sheng Wei** has won the Best Paper Award at the ACM Multimedia Systems Conference (MMSys 2020) for their paper titled "QuRate: Power-Efficient Mobile Immersive Video Streaming". ACM MMSys is one of the major conferences of the ACM Special Interest Group on Multimedia (SIGMM). It provides a forum for researchers to present and share their latest research findings in multimedia systems. This work was conducted by Prof. Wei and his PhD student Nan Jiang, in collaboration with researchers from both academia and industry (SUNY Binghamton, WPI, SUNY Buffalo, Adobe Research, and UNL).

In addition to the Best Paper Award, the paper also won the DASH-IF Excellence in DASH Award (3rd place) presented at ACM MMSys 2020. This award acknowledges papers substantially addressing MPEG-DASH (i.e., the international standard for adaptive video streaming over HTTP) as the presentation format and are selected for presentation at ACM MMSys 2020. Preference is given to practical enhancements and developments which can sustain future commercial usefulness of MPEG-DASH. Congratulations to Sheng and his team on this recognition!

The abstract of the award winning paper is below: Smartphones have recently become a popular platform for deploying the computation-intensive virtual reality (VR) applications, such as immersive video streaming (a.k.a., 360-degree video streaming). One specific challenge involving the smartphone-based head mounted display (HMD) is to reduce the potentially huge power consumption caused by the immersive video. To address this challenge, we first conduct an empirical power measurement study on a typical smartphone immersive streaming system, which identifies the major power consumption sources. Then, we develop QuRate, a quality-aware and user-centric frame rate adaptation mechanism to tackle the power consumption issue in immersive video streaming. QuRate optimizes the immersive video power consumption by modeling the correlation between the perceivable video quality and the user behavior. Specifically, QuRate builds on top of the user's reduced level of concentration on the video frames during view switching and dynamically adjusts the frame rate without impacting the perceivable video quality. We evaluate QuRate with a comprehensive set of experiments involving 5 smartphones, 21 users, and 6 immersive videos using empirical user head movement traces. Our experimental results demonstrate that QuRate is capable of extending the smartphone battery life by up to 1.24X while maintaining the perceivable video quality during immersive video streaming. Also, we conduct an Institutional Review Board (IRB)-approved subjective user study to further validate the minimum video quality impact caused by QuRate. (i) providing a novel framework for antenna selection, (ii) developing a SLA MIMO radar prototype

## Professor Yingying Chen receives Peter D. Cherasia Faculty Scholar Award


Y. Chen

Dean **Thomas N. Farris** has announced that Professor **Yingying Chen** has been selected for the Peter D. Cherasia Faculty Scholar Award!

The Cherasia Award, established by Peter D. Cherasia, a Rutgers ECE alumnus, recognizes and fosters excellence in teaching and scholarly activity in highly quantitative and computational aspects of engineering research. The Award is for a three-year term and includes $10,000 per year that can be used to support scholarly activity.

## Athina Petropulu to lead IEEE Signal Processing Society

**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.

## ECE Researchers receive NSF Grant for Design of MIMO Radar with Sparse Linear Arrays

A. Petropulu

A team of ECE researchers led by Distinguished Professor Athina Petropulu (PI) has received a new NSF award titled "MIMO Radar with Sparse Linear Arrays - Theory, Implementation and Applications." This project includes Professor Yingying Chen and Assistant Professor Chung-Tse Michael Wu as Co-PIs. The total award amount for the three-year project is $450,000.

The project aims to design Multiple-Input Multiple-Output (MIMO) radars that have several advantages as compared to traditional phased arrays. They can achieve higher resolution with the same number of antennas. They can also achieve a wide field of view, illuminating multiple targets at the same time, which translates to faster detection time. Reduction of the number of active antennas without hurting the radar performance would reduce the cost of the radar. As such, a low-cost, high resolution radar would advance the state-of-art of smart environment, smart home, and IoT sensing, thereby enabling applications such as smart patient care, elderly monitoring, fitness assistant, etc., that rely on sensing. In an era where COVID-19 forced home isolation with limited supervision of vulnerable segments of the population, a radar device could provide information on vital signs, or detect falls without invading people's privacy in the way surveillance cameras would. MIMO radar using specially designed Sparse Linear Arrays (SLAs) can enjoy reduced hardware cost without losing the MIMO radar advantages. A SLA can be thought of as a uniform linear array with only a small number of active antennas. By careful selection of the active antennas and optimal design of transmit waveforms, one can maintain a radar performance close to that of the fully populated array. However, finding an optimal sparse array geometry in terms of the fewest antennas is a difficult combinatorial problem. The proposed project will advance the state of art of SLA-based MIMO radar as a cost-effective imaging radar by (i) providing a novel framework for antenna selection, (ii) developing a SLA MIMO radar prototype based on frequency-scanning metamaterial (MTM) antennas, and (iii) developing real-time activity monitoring and user identification schemes that leverage the high resolution and wide field of view of MIMO SLA radar.

## Dario Pompili named ACM Distinguished Member

D. Pompili

Associate Professor **Dario Pompili** has been selected for the honor of 2019 ACM Distinguished Member for "Outstanding Scientific Contributions to Computing."

The Association for Computing Machinery (ACM) has named 62 Distinguished Members for outstanding contributions to the field. All 2019 inductees are longstanding ACM members and were selected by their peers for a range of accomplishments that have contributed to technologies that underpin how we live, work and play. The ACM Distinguished Member program recognizes up to 10 percent of ACM worldwide membership based on professional experience as well as significant achievements in the computing field. To be nominated, a candidate must have at least 15 years of professional experience in the computing field, 5 years of continuous professional ACM membership, and have achieved a significant level of accomplishment, or made a significant impact in the field of computing, computer science and/or information technology. In addition, it is expected that a Distinguished Member serves as a mentor and role model, guiding technical career development and contributing to the field beyond the norm.





# Rutgers Awarded $3M NSF Grant to Develop Robots of the Future

Marisol Seda

A $3 million National Science Foundation grant will help Rutgers train graduate students to develop robots for the future that integrate technology, computer science and machine learning with social and behavioral sciences like psychology, cognitive science and urban policy planning.

"The students may come from a technology background or from a social science background for this unified training of interdisciplinary skills," said **Kristin Dana,** professor of electrical and computer engineering in the School of Engineering, who has assembled an interdisciplinary team of faculty spanning five departments and three schools. "We are at a point in technology where robotics may soon be part of everyday life and work but we want robots to be developed in a way that they can adapt to human needs and desires, rather than the other way around."

The first major traineeship grant awarded to the School of Engineering is called Socially Cognizant Robotics for a Technology Enhanced Society (SOCRATES). Its mission is to converge socially aware technologists and technology aware social scientists into socially cognizant roboticists, Dana said.

K. Dana

The program will focus on semiautomated systems capable of performing daily life through the Robotics for Everyday Augmented Living (REAL) program, and is expecting to trainover 35 graduate students initially across the academic units of engineering, computer science, behavioral sciences, and public policy. Trainees will engage in fundamental research to understand and model the social dimensions of robot deployments and advance the long-term goal of dignified living and working in a technologically enhanced society. Some 100 students will benefit from some component of the program over the next five years.

The participants will be trained in the technology available for building and controlling robots;collectingand learning from large data sets; designing sociallycognizant systems; and planning for a positive societal impact while mitigating unintended consequences.

"We plan to do experiments using our Rutgers Robotics Live Lab with key application domains like strength and mobility, recycling and trash collection, food preparation and smart buildings," Dana said.

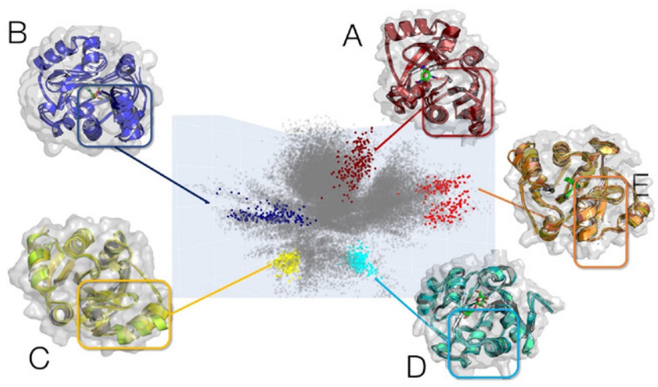
A multifaceted approach will be used to recruit students from various disciplines, including the student-led robotics club that focuses on a novice-to-expert (N2E) strategy used to motivate and help students who want to learn discipline-drobotics but have no prior experience.

By taking the intimidation factor out of learning a new coding skill, Dana said the N2E student-led modules are welcoming to beginners and encourage participation. The NRT recruitment strategy will also include a Faculty Talk-it-up Robotics Series for recruiting underrepresented populations. The program will also coordinate internships that are aligned with changing workforce and research needs.

Dana and her team worked on their SOCRATES proposal for two years. The SOCRATES proposal team consisted of: **Kristin Dana,** professor of electrical and computer engineering, School of Engineering; **Kostas Bekris,** associate professor, computer science department, School of Arts and Sciences; **Clinton Andrews,** professor of urban planning and associate dean for research, Edward J. Bloustein School of Planning and Public Policy; **Jacob Feldman,** professor of psychology and cognitive science, School of Arts and Sciences; **Jingang Yi,** professor of mechanical and aerospace engineering, School of Engineering; **Pernille Hemmer,** associate professor of psychology and cognitive science, School of Arts and Sciences; **Aaron Mazzeo,** associate professor of mechanical and aerospace engineering, School of Engineering; **Hal Salzman,** professor of planning and public policy, Edward J. Bloustein School of Planning and Public Policy; **Matthew Stone,** professor and department chair of computer science, School of Arts and Sciences; **Kathy Haynie**, director of Haynie Research and Evaluation and the team's external evaluator on STEM education.

# ECE Faculty Members Make Key Contributions to Design of Drug Molecules for COVID-19

**Aaron Dubrow**




AI-driven molecular dynamics simulations provide insights into how different ligands modulate the binding region of the viral ADP-ribose-1′-phosphatase protein. Ligands are shown in stick-like representation and the protein is shown as a cartoon ensemble. Note that each ligand has an effect on distinct regions of the protein. [Credit: Argonne National Laboratory]

Rutgers ECE department's contribution to a consortium of Department of Energy (DOE) National Laboratory and Universities to design promising drug molecules for COVID-19.

Central to the success of this work are software and AI methods developed by the RADICAL Lab directed by ECE Professor **Shantenu Jha.** In addition to possibly being the "fastest" drug design pipeline anywhere in the world, it also has the potential to be the most sophisticated-pipeline —combining artificial intelligence with physics-based drug docking and molecular dynamics simulations to rapidly and accurately hone in on the most promising molecules. The consortium is a short time away from publishing its initial recommendation of drugmolecules.Graduate student —**Aymen Al-Saadi,** and researchers —**Hyungro Lee, Mikhail Titov** and **Andre Merzky,** ECE Assistant Research Professor **Matteo Turilli** and Professor Jha have worked endless hours since early March to stand-up these capabilities on the world's fastest supercomputer.

## AI FAST-TRACKS DRUG DISCOVERY TO FIGHT COVID-19

A global race is underway to discover a vaccine, drug, or combination of treatments that can disrupt the SARS-CoV-2 virus, which causes the COVID-19 disease, and prevent widespread deaths.

While researchers were able to rapidly identify a handful of known, Food and Drug Administration-approved drugs that may be promising, other major efforts are underway to screen every possible small molecule that might interact with the virus —and the proteins that control its behavior —to disrupt its activity.

The problem is, there are more than a billion such molecules. A researcher would conceivably want to test each one against the two dozen or so proteins in SARS-CoV-2 to see their effects. Such a project could use every wet lab in the world and still not be completed for centuries. Computer modeling is a common approach used by academic researchers and pharmaceutical companies as a preliminary, filtering step in drug discovery. However, in this case, even every supercomputer on Earth could not test those billion molecules in a reasonable amount of time. "Is it ever going to be possible to throw all of computing power available at the problem and get useful insights?" asks Arvind Ramanathan, a computational biologist in the Data Science and Learning Division at the U. S. Department of Energy's (DOE) Argonne National Laboratory and a senior scientist at the University of Chicago Consortium for Advanced Science and Engineering (CASE).

In addition to working faster, computational scientists are having towork smarter.

A large collaborative effort led by researchers at Argonne combines artificial intelligence with physics-based drug docking and molecular dynamics simulations to rapidly hone in on the most promising molecules to test in the lab.

Doing so turns the challenge into a data, or machine-learning-oriented, problem, Ramanathan says. "We're trying to build infrastructure to integrate AI and machine learning tools with physics-based tools. We bridge those two approaches to get a better bang for the buck."

The project is using several of the most powerful supercomputers on the planet —the Frontera and Longhorn supercomputers at the Texas Advanced Computing Center; Summit at Oak Ridge National Laboratory; Theta at the Argonne Leadership Computing Facility (ALCF); and Comet at the San Diego Supercomputer Center —to run millions of simulations, train the machine learning system to identify the factors that might make a given molecule a good candidate, and then do further explorations on the most promising results."

TACC has been critical for our work, especially the Frontera machine," Ramanathan said. "We've been going at it for a while, using Frontera's CPUs to the maximum capacity to rapidly screen: taking virtual molecules and putting them next to a protein to see if it binds, and then infer from it whether other molecules will also do the same."

Doing so is no small task. In the first week, the team tested six million molecules. They are currently simulating 300,000 ligands per hour on Frontera.

"Having the ability to do a large amount of calculations is very good because it gives us hits that we can identify for further analysis."

## HONING IN ON A TARGET

The team began by exploring one of the smaller of the 24 proteins that COVID-19 produces, ADRP (adenosine diphosphate ribose 1" phosphatase). Scientists do not entirely understand what function the protein performs, but it is implicated in viral replication.

Their deep-learning plus physics-based method is allowing them to reduce 1 billion possible molecules to 250 million; 250 million to 6 million; and 6 million to a few thousand. Of those, they selected the 30 or so with the highest "score" in terms of their ability to bind strongly to the protein, and disrupt the structure and dynamics of the protein —the ultimate goal.

They recently shared their results with experimental collaborators at the University of Chicago and the Frederick National Laboratory for Cancer Research to test in the lab and will soon publish their data in an open access report so thousands of teams can analyze the results and gain insights. Results of the lab experiments will further inform the deep learning models, helping fine-tune predictions for future protein-drug interactions.

The team has since moved on to the COVID-19 main protease, which plays an essential role in translating the viral RNA, and will soon begin work on larger proteins which are more challenging to compute, but may prove important. For instance, the team is preparing to simulate Rommie Amaro's all-atom model of entire virus, which is currently being produced on Frontera.

The team's work uses DeepDriveMD—Deep-Learning-Driven Adaptive Molecular Simulations for Protein Folding —a cutting-edge toolkit jointly developed by Ramanathan's team at Argonne, along with Shantenu Jha's team at Rutgers University/ Brookhaven National Laboratory (BNL) originally as part of the Exascale Computing Project.

Ramanathan and his collaborators are not the only researchers applying machine and deep learning to the COVID-19 drug discovery problem. But according to Arvind, their approach is rare in the degree to which AI and simulation are tightly-integrated and iterative, and not just used post-simulation.

"We built the toolkit to do the deep learning online, enabling it to sample as we go along," Ramanathan said. "We first train it with some data, then allow it to infer on incoming simulation data very quickly. Then, based on the new snapshots it identifies, the approach automatically decides if the training needs to be revised."

The system first establishes the binding stability of potential molecules in a fairly simple way, then adds more and more complex elements, like water, or performs finer analyses of the energy profile of the system. "Information is added at different funneling points and based on the results, it mightneed to revise the docking or machine learning algorithms."

Frontera contributes to AI-and physics-based research that aims to speed the identification of potential drugs to treat COVID-19.

Its complex workflows are carefully orchestrated across multiple supercomputers using RADICAL-Cybertools, advanced workload execution and scheduling tools developed by computational experts at Rutgers/BNL.

"The workflows have sophisticated requirements," said Shantenu Jha, chair of BNL's Center for Data-Driven Discovery and thelead of RADICAL. "Thanks to TACC's technical support we were able to achieve both the desired levels of throughput and scale on Frontera and Longhorn within a couple of days and start production runs."

## APPLYING THE WEAPONSOF SCIENCE

The team had some advantages in getting their research off the ground.

The U. S. Department of Energy operates some of the most advanced x-ray crystallography labs in the world, and collaborates with many others. They were able to quickly extract the 3D structures of many of the COVID-19 proteins — the first step in doing computational modeling to explore how such proteins respond to drug-like molecules.

They also were actively working on a project with the National Cancer Institute to use the DeepDriveMD workflow to identify promising drugs to combat cancer. They quickly pivoted to COVID-19 with tools and methods that had already been tested and optimized.

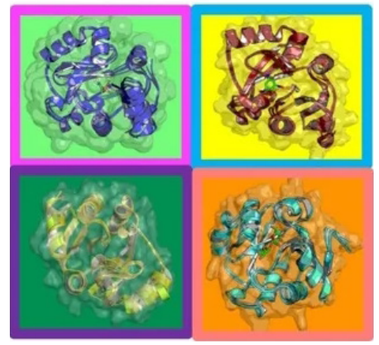
**"In times of global need like this, it's important not only that we bring all of our resources to bear, but that we do so in the most innovative ways possible."**

TACC Executive Director Dan Stanzione

Though AI is frequently considered a black box, Ramanathan says their methods do not just blindly generate a list of targets. DeepDriveMD deduces what common aspects of a protein make it a better candidate, and communicates those insights to researchers to help them understand what is actually happening in the virus with and without drug interactions."

Our deep learning models can hone in on chemical groups that we think are critical for interactions," he said. "We don't know if it's true, but we find docking scores are higher and believe it captures important concepts. This is not just important for what happens with this virus. We're also trying to understand how viruses work generally."

Once a drug-like small molecule is found to be effective in the lab, further testing (computational and experimental) is required to go from a promising target to a cure."



The researchers are currently simulating 300,000 ligands per hour on Frontera. In the first week, they tested six million molecules. [Credit: Argonne National Laboratory]

Developing vaccines takes such a long time because molecules need to be optimized for function. They must be studied to determine that they're not toxic and don't do other harm, and also that they can be produced at scale," Ramanathan said.

All of these further steps, the researchers believe, can be accelerated by the use of a hybrid AI-and physics-based modeling approach.

According to Rick Stevens, Argonne's associate laboratory director for Computing, Environment and Life Sciences, TACC has been extremely supportive of their efforts."

The rapid response and engagement we have received from TACC has made a critical difference in our ability to identify new therapeutic options for COVID-19," Stevens said. "Access to TACC's computing resources and expertise have enabled us to scale up the research collaboration applying advanced computing to one of today's biggest challenges."

The project compliments epidemiological and genetic research efforts supported by TACC, which is enabling more than 30 teams to undertake research that would not otherwise be achievable in the timeframe this crisis requires.

"In times of global need like this, it's important not only that we bring all of our resources to bear, but that we do so in the most innovative ways possible," said TACC Executive Director Dan Stanzione. "We've pivoted many of our resources towards crucial research in the fight against COVID-19, but supporting the new AI methodologies in this project gives us the chance to use those resources even more effectively."

# alumninews

## Cem Saraydar leads GM R&D in driving automation and connected vehicle technology


C. Saraydar

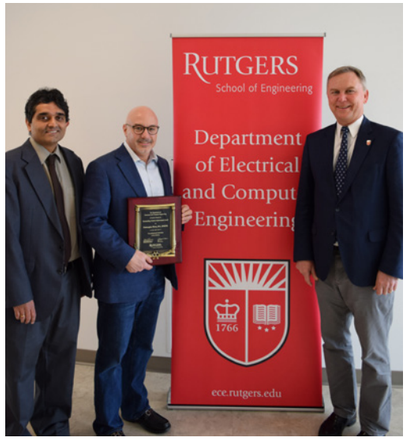
**Cem Saraydar** is Director of the Electrical and Control Systems Research at General Motors. In this post, he leads GM R&D's advanced technical work activity in the areas of driving automation, connected vehicle, and related enabling technologies. He joined GM R&D as a researcher in 2005. Before joining GM, Saraydar worked in Bell Labs, Holmdel, NJ and at the New Jersey Institute of Technology, Newark, NJ. Saraydar received his bachelor's degree in electrical and electronics engineering from Bogazici University, Istanbul, Turkey and master's and Ph.D. degrees in electrical engineering from Rutgers University. Throughout his career, he authored over 30 papers and 20 patents.

During his tenure at GM, Saraydar had a number of different appointments in R&D, Vehicle Engineering and Onstar. In 2002, he completed the Emerging Leader Program administered by Harvard Business School. He is currently overseeing major innovation programs in critical strategic growth areas for General Motors, including a major initiative in autonomous vehicle development. Saraydar also directs his lab's activities with partners across a diverse external technology collaboration network, which include HRL, CAMP and several universities around the globe.

Saraydar serves on the Electrical and Electronics technical leadership council of USCAR and co-directs the CMU Collaborative Research Lab. Dr. Saraydar also serves as technical director of GM's research activities with HRL. In addition, Saraydar serves on an advisory board for Wayne University. Saraydar is a recipient of the 2015 *IEEE Communications Society Award for Advances in Communication* along with Narayan Mandayam and David Goodman. He holds a Black Belt in Design for Six Sigma. He was elected President of Sigma Xi GM Chapter in 2009, which he served for one term. Dr. Saraydar has presented numerous keynote and guest lectures, served on dissertation committees, and contributed to NSF panels.

In the early part of his career Dr. Saraydar established a track record of applying one area of STEM in solving problems in another. His master's thesis work included application of game theory to location area partitioning in cellular networks. His doctoral thesis pioneered applying the microeconomic tools of game theory to design algorithms for wireless resource management. The bulk of his dissertation work was published in the paper "Efficient Power Control via Pricing in Wireless Data Networks," that appeared in the IEEE Trans. on Communications, vol. 50, no. 2, pp. 291-303, Feb 2002, and is considered as a seminal contribution to the field. The fundamental connections made in this work between the efficiency of resource allocation and interference management using "pricing" (a form of policing) form the basis of radio resource management algorithms that are used in real-world wireless networks such as 3G and 4G cellular systems. The contributions of this paper continue to have an impact even today in the design of cognitive radio enabled dynamic spectrum access as well resource management in HetNets as envisioned in future wireless systems. Dr. Saraydar was awarded the 2015 *IEEE Communications Society (COMSOC) Award for Advances in Communication for the above paper. The Advances in Communication* Award is the highest paper award given by the COMSOC and is given to an outstanding paper published in any IEEE Communications Society publication in the previous 15 calendar years.

## Chris Marty recognized with the ECE Distinguished Alumnus of the Year Award



Chris Marty (center) with Dr. Narayan Mandayam (left) and Dean Thomas N. Farris (right)

Dr. **Chris Marty** (ECE, Class of 1993) was recognized with the 2019 ECE Distinguished Alumnus of the Year Award on December 6 at an event held in the Richard Weeks Hall of Engineering. He is a Portfolio Manager and Managing Director at Two Sigma Investments LLC, a quantitative hedge fund located in Manhattan. In this role, Chris combines financial modeling with large scale computing to deliver superior investment results.

Prior to joining Two Sigma, Marty was head of Portfolio Analytics at Bloomberg LP. He was a founding member of the Bloomberg Portfolio Analytics system ALPHA and ran both software development and financial modeling. The system is used by thousands of Bloomberg customers to perform complex portfolio risk and performance analysis. Before joining Bloomberg, Chris was a senior technical staff member with AT&T Labs Research where he focused on network operating systems and digital rights management. Chris obtained his PhD in Computer Engineering from the City University of New York.

Chris is an active champion of the ECE Department — serves on its Advisory Board and mentors and engages students conducting research in information sciences. He is married to fellow ECE Alumna Rita Marty who is a Vice President at AT&T.

# 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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