ecenews

Department of Electrical and Computer Engineering

2024

RUTGERS–NEW BRUNSWICK
School of Engineering

ECE Newsletter

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ECE News is an annual publication of Rutgers ECE.

ECE Newsletter Committee: Prof. Yingying (Jennifer) Chen, Pamela Heinold, John Scafidi, Sheng Wei, Daniel Burbano Lombana

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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

Welcome to the Department of Electrical and Computer Engineering at Rutgers

Welcome to the Electrical and Computer Engineering (ECE) Department at Rutgers University. We are thrilled to announce that our institution has continued to make remarkable progress in the prestigious U.S. News & World Report college rankings. Rutgers-New Brunswick has ranked as the #15 top public university in the nation and 41th among all national universities, further reinforcing its reputation for exceptional education and impactful research. Additionally, all three Rutgers campuses have consistently placed among the top 100 national universities. As we embark on another exciting year at Rutgers, we are delighted to reflect on numerous accomplishments and ongoing innovations in our department.

In line with the previous year's success, the ECE department continues to excel in securing competitive external funding, bringing in over $10 million in new research grants. Awarded by prestigious organizations such as the National Science Foundation (NSF), Army Research Lab (ARL), and National Institutes of Health (NIH), this funding will support groundbreaking initiatives across a range of disciplines. Some of the highlights include a $1.2 million NSF grant for the "hpcGPT" project, a $1 million NIH award for developing the CAMERA platform to measure anxiety and memory states, a $800,000 NSF NewSpectrum project for addressing spectrum situational awareness and protection from interference, and a $800,000 NSF project on backscatter fabric for multidimensional spectrum situational awareness and protection. The department's research

ECE By The Numbers

36 Faculty

8 Lecturers

151 MS Students

870 Undergraduate Students

278 Graduate Students

124 PhD Students

$12 MIL New Research Grants

1903-2023 Celebrating ***120*** years

the Chair

continues to drive advancements in wireless communication, AI security, and spectrum management.

Collaboration remains a cornerstone of our department's research strategy, with significant partnerships across institutions. The department was a key player in several major collaborative projects, including a $1.2 million NSF collaborative project with George Mason University and Temple University focusing on WiFi-based suspicious in-baggage object detection, which is a timely project to enhance public safety. Another notable collaboration with the University of Illinois at Chicago resulted in a $1.4 million ARL award for developing AI solutions for tactical networks. These partnerships have allowed the department to expand its research impact across diverse fields, such as immersive multimedia systems, spectrum management, and adversarial machine learning.

Our research infrastructure also continues to offer excellent opportunities for students and faculty. This year, the Wireless Information Network Laboratory (WINLAB) has expanded its collaboration with national and international partners, securing key roles in the $42 million NTIA ACCoRD consortium, which focuses on developing advancing wireless networks through Open RAN technology and the Open RAN deployments with major industry players like AT&T and Verizon. These efforts, combined with faculty awards and student accomplishments, reflect the department's active engagement in research and its commitment to driving the future of electrical and computer engineering.

ECE students continue to shine in both academic and research activities. Our undergraduates presented their capstone project at the 2024 IEEE International Symposium on Consumer Technology in Indonesia, marking an important milestone in their academic journey. Our graduate student and Rutgers SOCRATES fellow were selected to speak at The Future Leaders in Robotics and AI: Celebrating Diversity and Innovation Seminar Series by the Maryland Robotics Center. Additionally, our students received honors like the Chancellor's Research Excellence Award and the Chancellor's Leadership Award for their leadership and research impact. Student teams of the ECE department also won first place in national competitions, such as the IEEE VEXU Tournament of Champions, showcasing the department's commitment to providing hands-on, practical training for students. These achievements highlight the deep commitment of our students to excellence both in and beyond the classroom.

The faculty of ECE also consistently receive prestigious recognition for their research, teaching, and scholarly contributions. Our key department members were elevated to ACM Fellow and IEEE Fellow status for transformative contributions to computing science, communication networks, and AI-driven technologies. Accolades such as the Provost Award for Pioneering Research and Outstanding Engineering Faculty Award were awarded to distinguished faculty for their transformative contributions. In addition, two faculty members received the Presidential Fellowships for Excellence, underscoring their exceptional work in both scholarship and teaching. The department's faculty was also honored with multiple NSF CAREER Awards, with one notable grant exceeding $600,000 for research focused on scalable AI models. In addition, one of our faculty members was promoted to Full Professor, along with two colleagues advancing to Associate Professor with tenure. These accomplishments are a testament to the department's sustained leadership in cutting-edge research and educational innovation.

Throughout the year, the department has been highly engaged in outreach, seminars, and events, contributing significantly to knowledge dissemination and student engagement. The department organized multiple high-profile academic events, including 15 seminars and colloquia throughout the year. For example, the Rutgers Efficient AI Seminar (REFAI) series featured talks from experts at leading institutions such as Princeton University, Google DeepMind, and the University of Rochester. In addition to the AI-focused events, the department hosted colloquia with guest speakers from esteemed institutions like Duke University, Tufts University, and Lawrence Berkeley National Laboratory. The Irons Endowed Lecture was a highlight, featuring talks on machine learning and communication technologies. The ECE Capstone Expo once again highlighted the remarkable talents of our students, with Team 48's project on radar-based vital sign monitoring receiving the First Place Award and tying for Best in Research. Our ties with industry have also deepened, with more companies engaging with our students through internships, capstone projects, and mentorship opportunities.

The department also facilitated a series of community engagement events. We have successfully hosted about 900 undergraduate freshmen in Introduction to Engineering to learn about electrical and computer engineering, the ECE curriculum, the IEEE, career opportunities, and the BS/MS degree program. The ECE Diversity Committee hosted a "Women in ECE" event, discussing important topics including obstacles for women in ECE, how to empower women academically and professionally, and ideas to enhance mentorship and connections among female students. We also successfully hosted the ECE Research Day, where faculty, students, and industry leaders shared their latest research. A notable annual event in the department is the Rutgers Robotics Workshop, held as part of the NSF National Research Traineeship SOCRATES (Socially Cognizant Robotics for a Technology Enhanced Society) program. This year, the workshop featured a Plenary Speaker, Dr. Camillo J. Taylor, the Raymond S. Markowitz President's Distinguished Professor of the Computer and Information Science Department at the University of Pennsylvania. This successful event included poster sessions, panel discussions on current trends in robotics, and industry engagement, advancing the department's commitment to promoting collaboration between academia and industry

As we reflect on our achievements, we are energized by the possibilities that lie ahead. Our department remains committed to expanding our research footprint, providing exceptional education, and fostering a community where innovation thrives. I am confident that together, we will continue to push the boundaries of engineering and technology in the years to come.

Thank you to our dedicated faculty, hardworking students, and supportive alumni for making this an exceptional year.

Warm regards,

Yingying (Jennifer) Chen
Department Chair and Associate Director of WINLAB
Electrical and Computer Engineering

ECE Faculty

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

Aggelos Bletsas
Professor
IEEE Fellow, Distinguished Lecturer of IEEE, IEEE Communications Society G. Marconi Prize Paper Award
Research interests: scalable wireless communications and sensor networking, RFID and backscatter radio networks, wireless narrowband localization, inference and internet of things that think, software radio, battery-less wireless sensor networks

Daniel Burbano Lombana
Assistant Professor
Research Interests: Dynamical systems and control theory with an emphasis on distributed network systems, collective animal behavior, swarm intelligence, and robot autonomy.

Yingying (Jennifer) Chen
Professor & Department Chair
ACM Fellow, IEEE Fellow, Fellow of National Academy Inventors,ACM Distinguished Scientist, Peter D. Cherasia Faculty Scholar, NSF Career Award, Google Faculty Research Award, NJ Inventors Hall of Fame Innovator Award
Research Interests: Applied Machine Learning in Mobile Computing and Sensing, Internet of Things (IoT), Security in AI/ML Systems, Smart Healthcare, and Deep Learning on Mobile Systems.

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.

Narayan Mandayam
Distinguished Professor and Director of WINLAB
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.

Laleh Najafizadeh
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, AAAS 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.

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

Sasan Haghani
Teaching Professor and Undergraduate Director
Research Interests: Applied signal processing with applications in biomedical and environmental domains, network science, smart cities, renewable energy and smart grid, microgrids, home automation systems for smart grid, wireless sensor networks, and broadband communications.

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

Shirin Jalali
Assistant Professor
NSF Career Award
Research Interests: High-dimensional inference and inverse problems, computational imaging, machine learning, information theory, statistical signal processing

Mehdi Javanmard
Professor and Paul S. & Mary W. Monroe Endowed Faculty Scholar
NSF Career Award
Research Interests: Nanobiotechnology, BioMEMS, point of care diagnostics, biomarker detection, microfluidics,
electrokinetics, applications of nanotechnology to medicine and biology.

Dario Pompili
Professor
IEEE Fellow, ACM Distinguished Scientist, Rutgers-NB Chancellor's Scholar, NSF Career Award, ONR Young Investigator Award, DARPA Young Faculty Award
Research Interests: Wireless networking, underwater communications, mobile edge computing, Internet of things, distributed robotics/autonomy.

Shriram Ramanathan
Professor & Rodkin Weintraub Chair in Engineering
NSF Career Award, DoD Young Investigator Award
Research Interests: Oxide quantum materials and devices; electromagnetic materials; brain-inspired electronics

Dipankar Raychaudhuri
Distinguished Professor
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.

Anand D. Sarwate
Associate Professor
NSF Career Award, A Walter Tyson Award, Rutgers Board of Trustees Research Fellowship for Scholarly Excellence
Research interests: Machine learning, distributed systems and optimization with a focus on privacy and statistical methods.

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

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

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.

Bokyung Kim
Assistant Professor
HLF Young Researchers, NSF iREDEFINE, and EECS Rising Stars Fellow
Research interests: processing-in-memory, neuromorphic computing, emerging memories, machine learning acceleration, efficient hardware design, VLSI, computer architecture and system design, device modeling and analysis

Dov Kruger
Associate Teaching Professor

Demetrios Lambropoulos
Instructor

Hang Liu
Assistant Professor and Associate Undergraduate Director
NSF Career Award, IEEE CS TCHPC Early Career Researchers Award for Excellence in High-Performance Computing
Research Interests: High-Performance Computing, Graph Analytics, Machine Learning, Numerical Methods

Yao Liu
Assistant Professor
NSF Career Award
Research Interests: Immersive streaming, mobile/cloud and edge computing, and distributed systems.

Predrag Spasojevic
Professor
Research Interests: Communication and information theory, signal processing and representation, cellular and wireless systems, Ad Hoc 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.

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

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

Sheng Wei
Associate Professor
NSF Career Award
Research Interests: Hardware and system security, multimedia systems

Chung-Tse (Michael) Wu
Associate 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.

Guosong Yang
Assistant Professor
Research Interests: Switched and hybrid systems, networked control systems, learning in game theory, cyber-physical systems (CPS), and network security.

Bo Yuan
Associate Professor
NSF Career Award
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.

Zhao Zhang
Assistant Professor
Research Interests: High Performance Computing, Deep Learning, Distributed Systems, Cyberinfrastructure, Scientific Applications.

Minning Zhu
Assistant Teaching Professor
Research interests: Microwave and millimeter-wave antenna and array design, metamaterial-based antenna systems and circuits, RF-based in-sensor and near-sensor analog computing systems, and integrated neuromorphic computing system design.

Lecturers:

Michael Caggiano
Narendra Garg
Luis Garrido
Yinglung Liang
Milton Diaz-Munoz
Mehdi Nosrati
Russell Pepe
Krishnamurthy Raghunandan
Kamran Sirohi
Rensheng Wang Zhang

Faculty Emeritus

Sophocles Orfanidis
Deceased Professor, 2024
Research Interests: Statistical and adaptive signal processing, Audio signal processing, Electromagnetic waves and antennas.

Hana Godrich
Associate Teaching Professor
Retired 2022
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.

Yicheng Lu
Distinguished Professor Emeritus
Retired 2022
NSF Initiation Award, Rutgers Monroe Faculty Scholar, Faculty of the Year Award (2019)
Research Interests: Micro- and nano-electronics multifunctional oxides - based devices.

Roy Yates
Distinguished Professor Emeritus
Retired 2022
IEEE Fellow
Research Interests: Resource management in wireless systems, dynamic spectrum access and spectrum regulation, information theory for wireless networks and future internet architectures.

Richard Mammone
Professor Emeritus
Retired 2021
National Academy of Inventors
Research Interests: Communications pattern recognition, neural networks, signal processing, technology commercialization, processes involved with the innovation of new technology.

Jian Zhao
Professor Emeritus
Retired 2021
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.

Grigore Burdea
Professor Emeritus
Retired 2020
NSF Initiation Award
IEEE Virtual Reality Career Award
Research Interests: Virtual rehabilitation, telerehabilitation, haptics virtual reality.

Sigrid McAfee
Associate Professor Emeritus
Retired 2019
Research Interests: Defects in semiconductors, nanotechnology, financial engineering.

Peter Meer
Distinguished Professor Emeritus
Retired 2018
IEEE Fellow, AMiner Most Influential Scholar
Research Interests: Statistical approaches to computer vision.

Peddapullaiah Sannuti
Professor Emeritus
Retired 2017
IEEE Fellow
Research Interests: Simultaneous internal and external stabilization of linear time-invariant systems in the presence of constraints.

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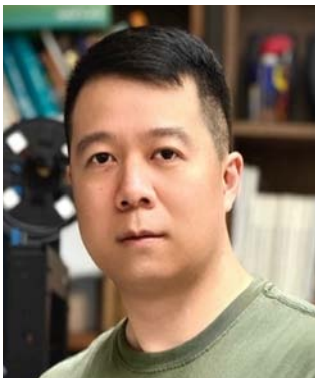
FACULTY News

ECE Welcomes New Faculty

Aggelos Bletsas received the Diploma degree (Hons.) in electrical and computer engineering from the Aristotle University of Thessaloniki, Greece, in 1998, and the S.M. and Ph.D. degrees from MIT, Cambridge, MA, USA, 1016 in 2001 and 2005, respectively. He has worked in Mitsubishi Electric Research Laboratories (MERL), Cambridge, MA, USA, in Radiocommunications Laboratory, Aristotle University of Thessaloniki, Greece and in School of ECE, Technical University of Crete, Greece. His research interests include span the broad area of scalable wireless communications and sensor networking. He was a co-recipient of the IEEE Communications Society 2008 Marconi Prize Paper Award in wireless communications, and the various Best (Student) Paper Awards from IEEE RFID-TA 2011, ICASSP 2015, RFID-TA 2017, MOCAST 2018, WCNEE 2021 and RFID 2023. One of his articles is ranked 1st in Google Scholar *Classic Papers in Computer Networks and Wireless Communication list.*

Bokyung Kim is an assistant professor in the Department of Electrical and Computer Engineering (ECE) at Rutgers University. Dr. Kim earned her Ph.D. in ECE from Duke University, after graduating with honors from Ewha Womans University in South Korea, where she received her M.S. and B.S. degrees in ECE and Electronics and Electrical Engineering, respectively. Her research area is focused on efficient processing-in-memory accelerators for machine learning. Dr. Kim has broad experience in hardware design, spanning different hardware levels through device modeling, mixed-signal VLSI, architecture/system design, and chip fabrication.

Dr. Kim has published eight first-authored and four co-authored papers at top-tier conferences and journals, such as HPCA, ICCAD, Nature Electronics, and TCAS-II during her Ph.D. study. Dr. Kim has been serving prestigious journals and conferences, mostly supported by IEEE/ACM as a reviewer, a session chair and a technical program committee member. Her contributions have been recognized in the field, winning the 2023 NSF iREDEFINE Professional Development Award from the ECE Department Heads Association and entering a selective fellowship, the 2023 EECS Rising Stars, the 11th HLF Young Researchers, and the 2024 ACM SIGDA DAC Ph.D. Forum.



Dr. Minning Zhu joined the Department of Electrical and Computer Engineering as an Assistant Teaching Professor in the fall of 2024. Prior to this role, he served as a postdoctoral researcher in the Microwave Research Lab at Rutgers University for three years. Dr. Zhu earned his Ph.D. in Electrical and Computer Engineering from Rutgers in 2021. His research interests encompass microwave and millimeter-wave antenna and array design, metamaterial-based antenna systems and circuits, RF-based in-sensor and near-sensor analog computing systems, and integrated neuromorphic computing system design.

Faculty Promotions for 2024

Umer Hassan promoted to Associate Professor with Tenure

Bo Yuan promoted to Associate Professor with Tenure

Matteo Turilli promoted to Associate Research Professor

Laleh Najafizadeh promoted to Full Professor

Sasan Haghani promoted to Full Teaching Professor

Faculty Emeritus

(*continued*)

Lawrence Rabiner
Distinguished Professor Emeritus
Retired 2016
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.

David Daut
Deceased Professor, 2015
Research Interests: Comminications and information processing, stochastic processes in communication, detection and estimation theory, multidimensional digital signal processing, optical communication systems

Michael Bushnell
Professor Emeritus
Retired 2013
IEEE Fellow
Research Interests: computer aided design (CAD) of very large scale integrated (VLSI) circuits

Paul Panayotatos
Deceased Professor, 2013
Research Interests: solar cells and optical interconnects

Michael Caggiano
Professor Emeritus
Retired 2010
Expertise: Electrical packaging, microwave packaging, analog circuit design, digital circuit design, digital circuit and logic design.

ECE department thanks retired faculty for their long service and commitment to teaching and research.

Retired Faculty John McGarvey

John McGarvey

John inspired many of our faculty by demonstrating a deep commitment to student learning outcomes. As a dedicated member of the TA Oversight Committee, he consistently offered insightful suggestions to enhance the undergraduate experience. John's presence in the department will be profoundly missed. – **Waheed Bajwa**

John McGarvey was a highly dedicated educator in our department, known for his unwavering commitment to student success and passion for teaching. His engaging lectures and genuine care for his students made him a beloved figure, and his impact on both their academic and personal growth was profound. Upon his retirement, faculty and students alike deeply missed his presence, reflecting on the invaluable contributions he made throughout his career. It was a real pleasure working with John. – **Yingying Chen**

Hardly any person in academia has been admired by all students, all teaching assistants, all staff, and all faculty and colleagues. Fortunately, we were very lucky to have one of them, Professor John McGarvey. Wishing him wonderful retirement and looking forward to seeing him back to Rutgers on a part-time basis. – **Zoran Gajic**

John's teaching style and interactions with his students, exemplifies a teacher dedicated to the best outcomes for his students. – **Narayan Mandayam**

I mostly worked with John through the TA Oversight Committee but learned quite a lot from him about two challenging aspects of teaching: one administrative and one philosophical. On the administrative side, I learned how to think about the lab element of a course in terms of professional training for the students. I have taken this perspective in my own teaching by making professional development/skills as part of the learning outcomes for ECE 345. John also cared deeply about professionalism from the TAs. From a teaching philosophy perspective, I've learned a lot from John about how to that professionalism translates into showing that you care for students' needs. – **Anand Sarwate**

John's teaching was characterized by a remarkable blend of professionalism and empathy for his students. He was keenly aware of the challenges they faced and often went the extra mile to guide them towards university resources that could provide the support they needed. – **Wade Trappe**

Prof John McGarvey supports students, regardless of whether you're a teaching assistant, a grader, or just a student in his class. Whenever a student needs help, Prof. McGarvey is there. He listens and works with TAs to find a way to best support students. He recognizes the TA's hard work and provides guidance and suggestions if needed. I respect Prof. McGarvey's teaching philosophy and feel privileged to work for him as a grader and a teaching assistant. – **Lingyi Xu**

ECE Faculty Yingying Chen Selected as Top Professor of Electrical and Computer Engineering of the Year 2023 for IAOTP

ECE Professor **Yingying Chen** has been selected as Top Professor of Electrical and Computer Engineering of the Year 2023 by the International Associate of Top Professionals (IAOTP).

While inclusion with the International Associate of Top Professionals (IAOTP) is an honor, only a few members in each discipline are chosen for this distinction. These special honorees are distinguished based on their professional accomplishments, academic achievements, leadership abilities, and contributions to their communities. Honorees are shown on the NASDAQ Billboard and invited to attend the IAOTP's Annual Awards Gala at the iconic Plaza Hotel in NYC this December to honor their achievements.

To name a few of the honorees in IAOTP 2023, Bobby Valentine (Former MLB Baseball Player and Top Legendary Baseball Management), Judge Jeanine Pirro (World Renowned Judge & TV Show Co-Host on Fox News Channel), Ronald Whittemore (Top Senior Olympic Athlete of the Decade), Gavin Maloof (Co-Owner of NHL Stanley Cup Champions and the Vegas Golden Knights), Frank Mann (World Renowned Artist and Educator), and Mark Rivera (Award Winning American Saxophonist and Musical Director) are all among the honorees for IAOTP 2023.

Kristin Dana will be speaker at "AI Through a Rutgers Lens"

Kristin Dana

Artificial intelligence and machine learning tools are transforming human experience, from education and business to policy and health care. The unprecedented growth of AI presents exciting opportunities for improving lives globally, but it also intensifies profound ethical questions concerning privacy, data confidentiality, and bias.

A three-part series in NYC exploring artificial intelligence. NYC AI Series Part 2

Location: Microsoft's office at the UN

FACULTY Awards

ECE Faculty Yingying Chen Received the Prestigious Rutgers Provost Award for Pioneering in Research

Yingying Chen was with Provost Saundra Tomlinson-Clarke, Chancellor Francine Conway and female awardees at the Rutgers Chancellor and Provost Awards Ceremony for Faculty Excellence.

The annual Chancellor and Provost Awards for Faculty Excellence recognize Rutgers–New Brunswick faculty members who have made outstanding contributions. Dr. Chen is a world-renowned leader in mobile sensing and mobile systems security, where she made fundamental contributions for over 25 years in academia and industry. Her groundbreaking research has yielded a transformative impact on society, particularly in smart homes, smart healthcare, and public safety. This impact is substantiated by her patented innovations, influential contributions to IEEE standards, and extensive community and media recognition. Aerial Technologies' licensing of two of her patents since 2016 has resulted in the Leading Innovators in Wi-Fi Motion Analytics Award and successful products like the Remote Care Solution. Her media recognition, spanning prestigious outlets such as IEEE Spectrum, MIT Technology Review, Wall Street Journal, CNN, and Fox News, further highlights her work's broad-reaching impact. She has published 3 books, 300+ journals and refereed conference papers, and over 10 patents. Her work is highly cited with 16,000+ citations and h-index 70 per Google Scholar.

The Engineering Governing Council (EGC) Awards Professor of the Year award to ECE Faculty Member

Dr. Michael Caggiano won the Engineering Governing Council (EGC) Students' Professor of the Year Award. Rutgers School of Engineering (SoE) students selected one professor from each department who best exemplified the SoE mission of "Education, Research, and Service" in the 2023-2024 academic year for the Engineering Governing Council (EGC) Students' Professor of the Year Award.

ECE Faculty Aggelos Bletsas Elevated to IEEE Fellow

The ECE Department is proud to announce that our upcoming new faculty, **Aggelos Bletsas**, has been elevated to IEEE Fellow 2024 with the following citation:

for contributions to cooperative relaying and backscatter communication networks.

Rutgers ECE Faculty, Anand Sarwate and Salim El Rouayheb, Visit American University of Beirut

ECE Associate Professor **Anand D. Sarwate** was named a Distinguished Lecturer for the IEEE Information Theory Society for 2024 and 2025. As part of this lectureship, he is charged with promoting information theory and helping to form new IEEE chapters of the society. To that end, he traveled in July 2024 to give a talk at the American University of Beirut (AUB). Dr. Sarwate's lecture was on joint work with Rutgers ECE Professor **Waheed U. Bajwa** and ECE PhD Student (now graduated) **Batoul Taki**, as well as former ECE PhD Students **Mohsen Ghassemi** and **Zahra Shakeri**. Professor Bajwa and Dr. Taki presented this research as a tutorial at the IEEE IEEE Sensor Array and Multichannel Signal Processing Workshop (SAM 2024) earlier in the month.

AUB is a private, non-sectarian, and independent university located in Beirut, Lebanon. Dr. Sarwate was hosted by the Center For Advanced Mathematical Sciences (CAMS) at AUB. During his visit, he was joined by ECE Associate Professor **Salim El Rouayheb**, who received a masters' degree from AUB. As part of the visit they explored new collaboration opportunities with faculty researchers at AUB working on privacy and communication systems as well as potential longer-term engagement with CAMS around information theoretic methods for understanding large-scale machine learning and AI (ML/AI) systems.

ECE faculty Anand Sarwate appointed as a Distinguished Lecturer of the IEEE Information Theory Society 2024 to 2025

ECE Associate Professor **Anand D. Sarwate** has been appointed as a Distinguished Lecturer of the IEEE Information Theory Society for 2024 to 2025.

The Information Theory Society established the Distinguished Lecturers Program in 2009 to promote interest in information theory by supporting chapters who wish to invite prominent information theory researchers to give talks at their events. The Society aims to maintain ten Distinguished Lecturers each serving for two year terms. Typically, the ITSoc Distinguished Lecturers program provides funding for airfare and travel, and the local chapter funds accommodation and local expenses. If traveling to a different continent, visits to two locations are required. The distinguished lectures should be freely accessible to the public.

The selection criteria are: (a) the quality of the candidates' contributions to research in information theory and related areas, and (b) the ability of the candidates to deliver an excellent lecture to a broad audience. The candidates may be from any geographic region and any organization, e.g., academia, industry, or government. Nominations that promote diversity are encouraged. The Distinguished Lecturers are typically members of the IEEE Information Theory Society.

Current Rutgers faculty and former PhD students have also been ITSOC Distinguished Lecturers: current faculty Emina Soljanin (2015-2016) and Roy Yates (2019-2021), and former PhD students Sennur Ulukus (2018-2019), Aylin Yener (2019-2021), and Lalitha Sankar (2021-2022).

Collaborative Research on Securing Public Safety with WiFi-based In-baggage Suspicious Object Detection

By Professor Yingying Chen

Rutgers ECE Professor Yingying Chen, Associate Director-WINLAB, is leading a team that received a $1.2M NSF grant for the project "Securing Public Safety with WiFi-based In-baggage Suspicious Object Detection." This project aims to enhance public safety by developing a low-cost, portable system for detecting suspicious objects hidden in baggage using WiFi technology. Public safety has become an increasingly significant issue in the United States due to the potential threat posed by hidden weapons and homemade bombs in public places (e.g., public schools, theme parks, sports stadiums, and scenic areas) where extensive security checks are not available (Figure 1). Traditional security systems, such as X-ray machines and CT screening, are expensive and primarily deployed in high-security areas like airports and government buildings. This project proposes leveraging the widespread availability of WiFi infrastructure in public spaces to enable an innovative and cost-effective in-baggage suspicious object detection system. Toward this end, the project team designs and develops a novel in-baggage suspicious object detection system that utilizes extracted WiFi signal features to determine materials and shapes of hidden objects, subsequently identifying suspicious items. This groundbreaking technology represents a significant advancement in public safety, offering a portable and affordable solution by repurposing existing WiFi networks. In typical security check scenarios, the proposed system will be deployed at the entrance to a public place with a sensing area where people must pass through. As individuals carry their bags either standing or walking through the sensing area, the proposed non-intrusive security check system can detect suspicious objects hidden in the bags (Figure 2).

The Rutgers ECE team has developed a preliminary system prototype for in-baggage suspicious object detection using WiFi. The design of this system has been published and received the Best Paper Award at the 6th Annual IEEE Conference on Communications and Network Security (CNS 2018). An improved system robust to environmental changes has been developed and published at the 18th IEEE International Conference on Mobile Adhoc and Sensor Systems (MASS 2021). The results from the team's prior work have demonstrated the feasibility of using antenna array-based WiFi imaging to drive object shapes (Figure 3). Building upon its previous foundational work, the team will investigate and address the challenges of deploying the WiFi-based in-baggage suspicious object de-

Figure 1. Illustration of public venues that urgently demand low-cost, non-intrusive in-baggage suspicious object detection.

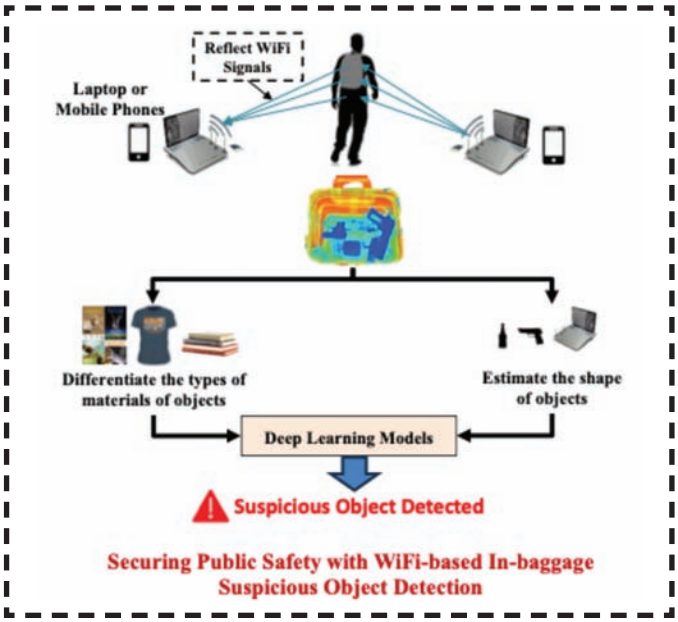


Figure 2. Illustration of the proposed WiFi-based in-baggage suspicious object detection system for securing public safety.

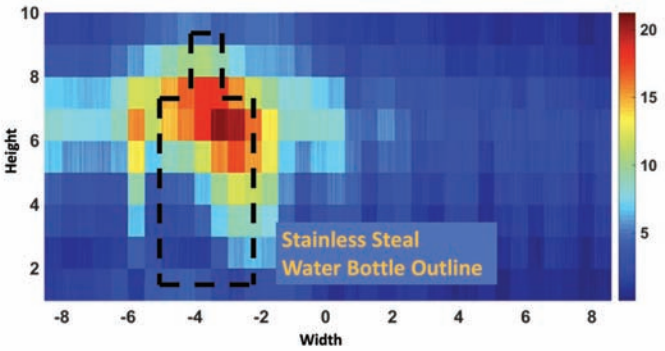


Figure 3. WiFi imaging result of a stainless steel water bottle.

tection system in practical scenarios. To mitigate the impacts from bag carriers, the team will develop new WiFi features based on the polarization of the reflected WiFi signals and Channel State Information (CSI) complex differences to determine the types of materials of objects inside bags. (e.g., metal, paper, cloth, plastic, and liquid). Furthermore, to model practical environmental factors, such as surrounding people and bag types, the team will design target identification models and domain adaptation frameworks based on deep learning techniques to ensure good identification accuracy in diverse environments and fast deployment in new environments (e.g., nearby people, bag types, furniture layouts). A robust shape reconstruction algorithm will be developed to recognize suspicious objects. Additionally, the team will create new mechanisms using directional antennas to mitigate the impact of the bag carrier's movements. The team will create a prototype system and validate the system's functionality, accuracy, and robustness. It will also work closely with technology collaborators and industrial partners for field trials and potential deployment into operational public environments.

Under collaboration with Professor Yan Wang from Temple University and Professor Xiaonan Guo from George Mason University, the outcomes of this project will revolutionize public safety measures by making advanced security accessible and affordable for a broader range of venues, thereby addressing the urgent need for enhanced safety in everyday public spaces. This project will seek to integrate the project's research efforts with educational activities such as developing graduate and undergraduate curricula and recruiting underrepresented students.

From the Classroom to the Yankees: Rutgers ECE and the Future of Sports Analytics

By Professor Jorge Ortiz

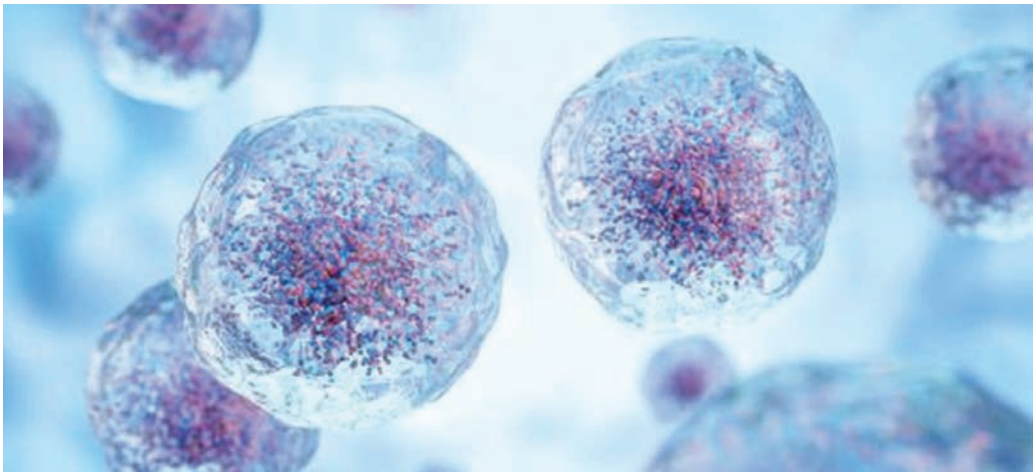
This past summer, Rutgers Electrical and Computer Engineering (ECE) student Ruben Alias applied his technical acumen in a context few would expect—within the New York Yankees' Quantitative Analysis division. Ruben had distinguished himself in several of my courses, demonstrating both depth of understanding and a capacity to push the boundaries of what we traditionally expect from students. It wasn't surprising when Ruben approached me seeking a summer opportunity; what followed was a natural extension of his prior performance, and I invited him to join the team. The work Ruben undertook was essential to the Yankees' ongoing efforts in data-driven decision-making, with his primary project focused on the development of advanced computer vision tools to streamline video analysis. The challenge here was not trivial. It required automating the identification and classification of various camera angles across different stadiums—no easy task, given the inconsistencies in video feeds and the varied contexts of the footage. Ruben's ability to integrate principles from machine learning and computer vision, built on the foundation of his coursework at Rutgers, allowed him to effectively tackle this problem with precision and rigor. The project Ruben contributed to aligns with a larger initiative we have been building within the Yankees' Quantitative Analysis division. My team focuses on leveraging AI and multimodal learning techniques, blending video analysis with statistical inference to generate insights that inform both player development and game strategy. While the sports world is increasingly adopting these advanced technologies, we are still in the early stages of exploring how deep learning architectures can be used to extract complex patterns from large-scale datasets, particularly in sports contexts where every minute detail can influence outcomes. Ruben's contributions directly supported this initiative, and his work was a valuable addition to our ongoing efforts.

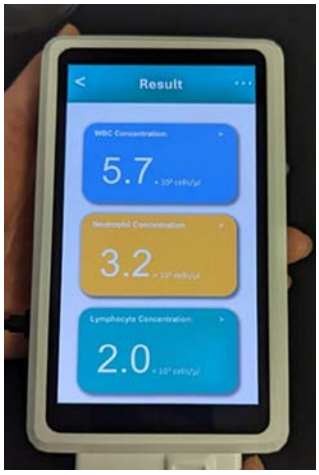
Professor Jorge Ortiz

Ruben Alias

Rutgers Researcher, Through Spinoff, Develops a Handheld White Blood Cell Tracker

By Professor Mehdi Javanmard





White blood cell levels, a critical signal of a patients immune system status, can be easily and rapidly tracked with a device developed by a Rutgers professor and his Rutgers startup company.

Device could enable rapid testing and improved triaging for infections and aid treatment for cancer or mental illness

A Rutgers researcher, through his spinoff company, has led a team to design and test a device that quickly counts a person's white blood cells with a single drop of blood, similar to the way glucometers rapidly scan for blood sugar levels.

The development of the device by researchers at Rutgers startup RizLab Health Inc. along with the clinical validation is described in the science and medical journal PLoS One. **Mehdi Javanmard**, a professor in the Department of Electrical and Computer Engineering in the Rutgers School of Engineering, is the co-founder and CEO of RizLab Health Inc, based in Princeton. He launched the startup based on advances in his Rutgers lab and with support from the Office for Research.

"Normally, doing a blood count requires a phlebotomist taking a needle stick and collecting significant amounts of venous blood and sending the samples off to labs where they are tested, sometimes taking hours or even days," Javanmard said. "Our handheld device enables near-patient testing, while only requiring a tiny amount of blood and returning results within minutes, allowing clinicians to make decisions almost immediately."

Called the CytoTracker Leukometer, the device is designed to quickly aid the detection of elevated or reduced white blood cell counts, a critical signal of a patient's immune system status. A high or low white blood cell count may indicate the intensity of an infection, the presence of life-threatening conditions such as sepsis or determine how patients are responding to chemotherapy and psychotropic drugs.

In collaboration with a clinical team at the Rutgers Robert Wood Johnson Medical School Pediatric Clinical Research Center led by Dr. Tanaya Bhowmick and the Baylor College of Medicine Department of Emergency Medicine, the device was successfully tested in trials by pitting the device in a head-to-head comparison with a lab benchtop hematology analyzer, a conventional blood testing technique.

"Rapid test results have revolutionized the field of medicine," said Bhowmick, an infectious disease physician and co-author of the paper. "The white blood count is a parameter that physicians routinely order to evaluate a patient for possible infection. Having this information rapidly can help triage patients in the outpatient setting."

The results showed the CytoTracker Leukometer to be at least 97% accurate and meet clinical standards.

White blood cells, or leukocytes, protect the body from infection. Colorless, they constitute about 1 percent of human blood and are formed mostly in the bone marrow. Certain subtypes of leukocytes have different functions. For example, neutrophils kill bacteria, fungi and foreign debris.

A low white blood cell count indicates that a person is prone to infection. A high white blood cell count means either an infection exists or there is an underlying medical condition.

Javanmard said he envisions multiple uses for the device. Sepsis in a patient entering an emergency room could more quickly be detected on the device than through present methods requiring a blood draw and a lab test, he said. Cancer doctors could rapidly determine whether patients undergoing chemotherapy need a white blood cell stimulant.

The device also may make it easier for psychiatry patients to stay on their medications. Patients taking clozapine, a common treatment for disorders such as schizophrenia, often experience neutropenia, or low levels of neutrophils. These patients are required to undergo regular testing for neutrophil levels before they can obtain a prescription. Javanmard said this often prevents patients from procuring much-needed treatment.

In his Rutgers lab, Javanmard and his students have sought to perfect the capabilities of a miniaturized electronic cytometric technique that detects microscopic particles by directing them through minute channels containing electrodes. The process is akin to scanning people as they move individually through an airport security gate, however using electrical signals instead of videography. In one recent advance, Javanmard said he and lab members used the cell-flow technique to develop a test so sensitive it could someday revolutionize medical approaches to epidemics. RizLab Health has focused on further advanced development and manufacturing of electronic cytometry with the goal of obtaining regulatory approval and ultimately commercialization.

Javanmard is excited about applying lab insights to practical problems to produce inventions like the CytoTracker Leukometer.

"We set out to solve one of the holy grails of medicine, which is to analyze a tiny amount of a patient's blood in a way to give guidance to clinicians and improve clinical outcomes," Javanmard said. "We believe this will have a huge impact in infectious disease, oncology, and psychiatry."

Javanmard added: "Others have made failed attempts to tackle this holy grail by aiming to identify dozens or even hundreds of biochemical constituents with a single drop of blood. Such attempts are fundamentally very difficult. As a result, we found it to be much more realistic to focus only on the white blood cells with the key sub-types as a start."

The device must be approved by the Food and Drug Administration before it can be commercialized and used for clinical applications, Javanmard said. It is presently for research use only.

Other scientists on the paper from Rutgers included Fei Chen, a staff nurse at the Rutgers Robert Wood Johnson Medical School Pediatric Clinical Research Center, and Sunanda Gaur, a pediatric infectious disease physician and director of the medical school's Pediatric Clinical Research Center. Scientists at Baylor included Kelly Keene, Farzad Soleimani and Zubaid Rafique.

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Intersection of Software and Hardware Innovation Conducted

By Professor Hang Liu

Assistant Professor Hang Liu joined the Department of Electrical and Computer Engineering in Spring 2023, after serving as a presidential fellowship assistant professor at the Stevens Institute of Technology and an assistant professor at the University of Massachusetts, Lowell. He is the recipient of a number of prestigious awards, such as the 2022 IEE CS TCHPC Early Career Researchers Award for Excellence in High-Performance Computing and a 2021 NSF Early CAREER Award, with research interests ranging from high-performance computing and graph analytics to machine learning and numerical methods.

Four Questions for Assistant Professor Hang Liu

What fueled your passion for ECE?
I am keenly interested in research innovations that lie at the intersection of software and hardware, which aligns with the themes of ECE and my current research focus on high-performance data analytics.

Who is most likely to benefit from your research?
Tech companies, such as Nvidia, Google, Meta, and Amazon, as well as U.S. Department of Energy researchers.

Do you have a campus lab, and are your students involved in your research?
Yes – my lab is focused on building high-performance systems for big data analytics. My students are working very closely with me on papers and projects.

What do you most enjoy about your department and the School of Engineering?
The collaboration opportunities are rich here in our school. Folks in my department are very friendly, and offer much help on my teaching and research.

INNOVATIVE Research

Dr. Umer Hassan's Immuno-engineering and Micro-nano Technologies for Personalized Healthcare (LIMPH)

Dr. Umer Hassan is an Associate Professor at the Department of Electrical and Computer Engineering (ECE) at Rutgers, The State University of New Jersey. He is the director of the Laboratory of **Immuno-engineering and Micro-nano technologies for Personalized Healthcare (LIMPH)** **www.hassan.rutgers.edu**. The core objective of Dr. Hassan's research group is to achieve global health equity. To enable this, his group develops next-generation biomedical technologies for deeper understanding of immunology, individualized monitoring of infectious diseases, engineering the immune response, and developing point-of-care sensors for global health applications. His R&D strategy encompasses comprehensive clinical translation pathway from biosensor technology development, characterization, and finally its validation in clinical studies. His research projects are being supported by several funding agencies including National Science Foundation (NSF), National Institutes of Health (NIH) and Office of Naval Research (ONR).

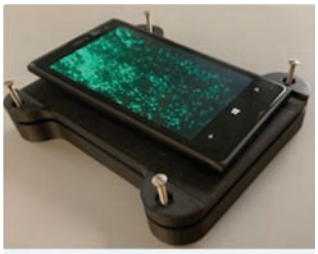
In the past 6 years at Rutgers, Dr. Hassan's lab has developed several technologies, some of these have been patented by the Rutgers Innovation Ventures as well. One of such technologies is called "Immuno-Dx," a microfluidic-based sensor for quantification of phagocytosis, our natural combat ability against pathogens. Phagocytosis is a cellular process by which white blood cells ingest and eliminate microorganisms, foreign substances, and apoptotic cells. Neutrophils are one population of white blood cells that can perform phagocytosis and are an important marker of immune system health. Neutrophils are key players in the early stages of white blood cell defense and are often the first white blood cells to the area of infection. Evaluating the phagocytic ability of neutrophils can provide insights into immune system (human's body natural defense) health and regulation. Recently, this technology received a US patent. In Fall 2023, Dr. Hassan's received an NSF PFI-TT award of 0.6 million USD to develop a minimal viable prototype which will be translated to healthcare settings and commercialized.

The Immuno-Dx team (including Dr. Umer Hassan, and his Ph.D. students Muhammad Tahir and Sophia Lowe) is one of the 24 teams selected nationally to participate in the National Science Foundation's I-Corps program this summer 2024. I-CORPS program is focused on customer discovery, finding a best product-market fit, and market segment analysis to successfully translate this technology into a commercial space. The rigorous program spans seven weeks and involves the essential training of inventors and young entrepreneurs in navigating the commercialization pathways of new ventures. As part of the program, the team conducts interviews with medical physicians and directors of emergency labs, pathology lab supervisors and directors, primary and critical care providers, and other stakeholders and key partners.

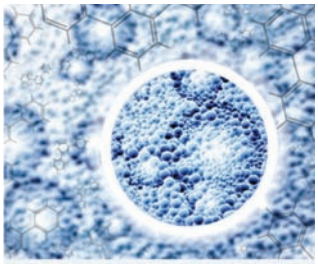
Dr. Hassan also holds courtesy appointment as an Associate Professor of Global Health at Rutgers Global Health Institute and a Full Graduate faculty member at Department of Biomedical Engineering. He regularly serves on grant review panels at NSF, NIH, and NASA. Dr. Hassan's group has strong clinical partnerships with Robert Wood Johnson Medical Hospital to validate his biotechnologies in clinical studies.

Muhammad Tahir (left) and Sophia Lowe (Right) attending Primed West 2024 convention during NSF I-CORPS program.

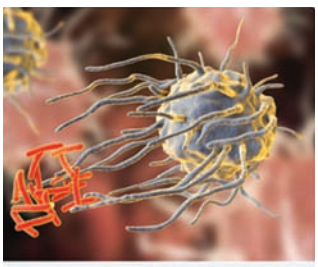
Multiplexed Biomarker Detection Technologies



Smartphone enabled Biosensors for Global Health



Eco-friendly Nanoparticles composites for Biomedical

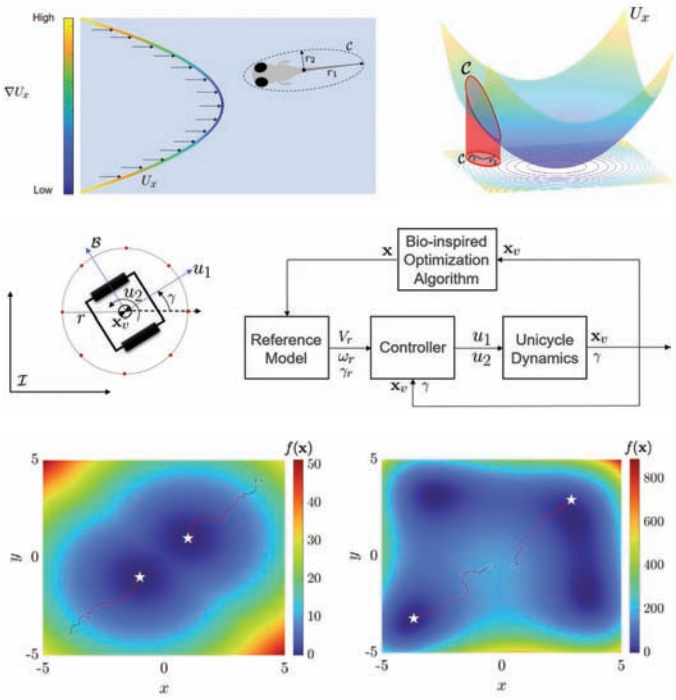


Monitoring and Engineering Phagocytic Ability

Research Themes being pursued in Dr. Hassan's laboratory at Rutgers.

Swimming Toward Innovation: Using Fish Behavior to Guide Autonomous Robots

By Professor Daniel Burbano Lombana



For centuries, natural systems have been a profound source of inspiration for engineering innovations. From the earliest observations of bird flight, which influenced Leonardo da Vinci's conceptual designs for flying machines, to modern advancements, the principles derived from nature have shaped countless technological breakthroughs. Nature's inherent efficiency, resilience, and adaptability offer invaluable lessons for solving complex engineering problems. Whether through biomimicry in architecture, robotics, or transportation, engineers continuously draw upon the natural world to create systems that are both sustainable and efficient.

Animals possess an extraordinary ability to navigate and orient themselves in complex environments. From migratory birds and fish solving long-distance localization challenges to rodents using internal maps to find food and evade predators. Understanding how animals sense, process, and utilize environmental information not only helps understand their adaptations but also inspires advancements in robotics and artificial intelligence. These insights can help develop autonomous systems capable of solving complex tasks without predefined global knowledge. For instance, moths use behaviors such as casting and zigzagging (anemotaxis) to locate food sources. This has inspired gradient-free optimization algorithms that enable robots to perform plume tracking in terrestrial, aerial, and underwater environments.

Zero-order optimization algorithms, often referred to as gradient-free algorithms, are methods used to optimize a function without needing to calculate its gradients directly. Unlike gradient-based methods, which require knowledge of the function's derivative, zero-order methods only rely on evaluating the function itself at different points. This makes them particularly useful in scenarios where calculating gradients is either infeasible or expensive, such as in real-world robotic applications where the environment is unknown or complex. In plume tracking, for example, robots equipped with sensors can gather local environmental data (e.g., wind speed, chemical concentration) without needing an explicit model of the field. These robots rely on zero-order algorithms to iteratively adjust their paths, using information from previous sensor readings to move toward the source of a plume. By calculating function values at multiple points, these algorithms estimate directional movement, enabling robots to solve complex optimization tasks like locating a target or navigating through challenging terrains, whether on land, in the air, or underwater.

Zebrafish larvae, like many other freshwater species, exhibit rheotaxis, the behavior of orienting themselves in response to an incoming current U_X. It has been established that larval zebrafish rely on hydromechanical cues to navigate flow environments by performing local computations of a line integral around their body as Illustrated in Figure 1. Specifically, when a fish swims in a parabolic flow, the ellipsoidal region around its body (denoted as C) symbolizes its ability to sense local flow conditions. This region's size can be adjusted using the parameters r_1 and r_2, which modulates the sensing capability of the fish. According to Stokes' theorem, the local circulation of the flow field experienced by the fish within the region C, is equivalent to the line integral of the flow field over the boundary of C. This suggests that the fish could potentially infer information about the gradient of the surrounding flow U_X by calculating this line integral.

Building on these biological insights from fish rheotaxis, we established a mathematical relationship between the line integral and the exact gradient of the flow field. This approach allowed us to explore how local measurements of the background flow, computed via line integrals, can be effectively used to estimate environmental gradients and guide fish navigation. Notably, these zero-order algorithms can be analyzed analytically, enabling us to derive mathematical proofs of their convergence time as a function of the sensing parameters and the properties of the objective functions, whether convex or nonconvex [1].

Interestingly, the bio-inspired algorithms from fish rheotaxis can be used to address the problem of target localization with autonomous robot collecting measurements from a scalar environmental field (such as temperature or fluid flow). This has wide-ranging applications, including detecting chemical spills, tracking ocean temperature changes, and early identification of forest fires. Specifically, the robot must localize an unknown target source without prior knowledge of the function governing the scalar field or its gradient. The robot relies on a collection of sensors arranged in a circular pattern around its frame (see Figure 2, left panel), each equally spaced to gather environmental measurements. Using these sensor readings, and leveraging our bio-inspired optimization algorithm, the robot is able to navigate the environment and localize the target (see Figure 2, right panel). Sample paths of the robot localizing the target are shown in Figure 3 (red trajectories), where the color scale represents the scalar field --deep blue indicating lower values.

These findings establish an important link between fish rheotaxis and zero-order optimization algorithms, offering direct applications for target localization in autonomous robots. This connection opens up promising opportunities to develop more robust and flexible bio-inspired optimization techniques that function without the need for precise models of the environment. Such techniques could significantly enhance the capability of autonomous systems to solve complex navigation and control problems in dynamic environments and facilitate their deployment in real-world scenarios.

[1] Burbano D. Yousefian F., "A Fish Rheotaxis Mechanism as a Zero-Order Optimization Strategy", IEEE Access, 2023.

INNOVATIVE Research

Continuous Multimodal Physiological Data Processing via Real-time In-situ Analog-Digital Machine Learning

Principal Investigator: Prof. Dario Pompili, PhD; Doctoral Students: Khizar Anjum, Yung-Ting Hsieh
Cyber-Physical Systems Laboratory (CPS Lab)
Department of Electrical and Computer Engineering, Rutgers University

Overview. Monitoring physiological responses in real time is essential for healthcare and research, aiding in early disease detection and prevention, including conditions like neurodegenerative disorders and heart failure. Continuous monitoring is especially crucial for ~1% of the global population with active epilepsy and for children, who face unique challenges due to their developmental stage. However, accurate monitoring is complex due to issues like data skewing from awareness of being monitored. To capture a comprehensive view of bodily functions, our CPS Lab is working on continuous, in-the-wild tracking via small wearable sensors with embedded Neural Network (NN) computation. This enables real-time, batteryless sensing, offering a sustainable, comfortable, and secure solution. We aim to advance science by pioneering new data collection methods in the Artificial Intelligence (AI) Era, before medical intervention becomes necessary.

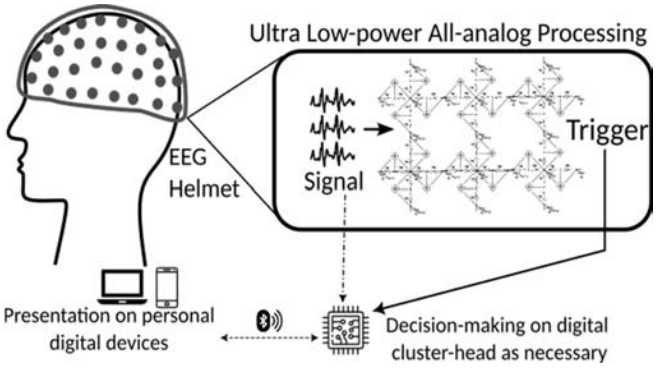


Figure 1: Ultra-low-power all-analog continuous processing of multimodal physiological data and subsequent in-situ post-processing at digital nodes via real-time Machine Learning (ML).

Relevant Efforts. While there are ongoing research efforts in this space, they are largely confined to their respective disciplines, creating a gap in interdisciplinary work that integrates AI with physical circuits. This siloed approach has left an untapped potential for transformative technologies that can only arise from the confluence of these fields. Our team at the CPS Lab is uniquely positioned to fill this gap, as we bring together expertise in both AI (software) and circuit design (hardware). This interdisciplinary focus allows us to venture into uncharted territories, developing groundbreaking technology that leverages the strengths of both disciplines. As such, our project not only addresses a critical need but also capitalizes on an opportunity for innovation that is currently underexplored.

Peer Groups. Previous research in the field of Body Area Networks (BANs) has developed low-energy digital sensing nodes capable of continuous computation and communication (Chen et al., Mob. Netw. Appl. [2011]), but these nodes are not comfortably wearable due to their large form-factor. Comparable technologies exhibit power consumptions of 2.79W (Li et al., IEEE TBCAS [2022]) and 4.5W (Chakraborty et al., Biomed. Signal Process. Control [2021]), indicating that, while they may be wearable, they are not suited for batteryless operation as they are too power hungry. A low-power activity classification system, introduced in (Fafoutis et al., IEEE WF-IoT [2018]), uses a straightforward implementation of Support Vector Machines (SVM); this implementation, however, is limited to feature extraction. Our proposal, in contrast, is a visionary approach that extends neural computation to the power-efficient circuit level.

Goals and Methodology. Our goal is to go beyond basic feature extraction in on-board signal processing, targeting advanced AI-based analytics that could transform the wearable and implantable device landscape. By embedding AI into these analog devices, we unlock the potential for real-time health monitoring, personalized treatment algorithms, and predictive analytics for early intervention. This capability could revolutionize not just healthcare but also other fields like sports science, mental health, and human-computer interaction. Our technology aims to do more than just monitor; it is designed to act as an intelligent system, providing real-time feedback for improved living and more accurate diagnoses, thereby bridging the human-machine divide. To achieve real-time and energy-efficient processing, we envision a two-tier wireless sensor network architecture, with multiple nodes for physiological sensing and processing, and a reduced number of cluster heads for efficient data aggregation and fusion. We have proposed techniques, including analog-domain data compression via Analog Joint Source-Channel Coding (AJSCC) for efficient transmission (Xuan and Narayanan, IEEE TCOM [2022]), the Folded Neural Network (FNN) for streamlined computation (Hsieh et al., IEEE MASS [2022]), and the Convolutional Processing Unit

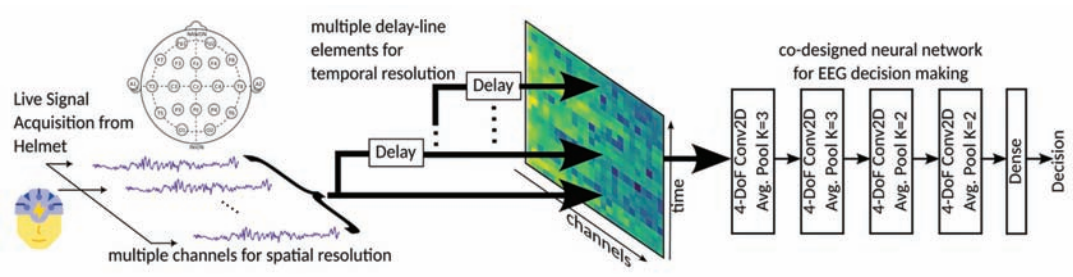


Figure 2: Our proposed scheme for co-designed all-analog spatio-temporal processing of EEG signals. The spatial array of signals is gradually delayed offering insight into the temporal behavior of the instantaneous signal. This spatio-temporal picture is then processed using multiple analog convolutional layers until a decision is reached.

GRANTS

Grants received by ECE faculty from 10/2023 to 09/2024

Dario Pompili received an NSF Grant for the project titled "xI_NGRAN–Navigating Spectral Utilization, LTE/WiFi Coexistence, and Cost Tradeoffs in Next Gen Radio Access Networks through Cross-Layer Design."

Shriram Ramanathan received a DARPA Grant for the project titled "Electron-Doping-Induced Low-Loss Modulation of Visible Light Using Nickelate Alloys."

Zhao Zhang received an NSF CAREER Grant for the project titled "Efficient and Scalable Large Foundational Model Training on Supercomputers for Science."

Umer Hassan received an NIH/NIAID Grant for the project titled "Urine Colorimetry for Tuberculosis Pharmacokinetics Evaluation in Children and Adults."

Zhao Zhang transferred an NSF Grant for the project titled "Collaborative Research: CSR: Medium: Fortuna: Characterizing and Harnessing Performance Variability in Accelerator-rich Clusters" to Rutgers.

Jorge Ortiz received an NIH Grant for the project titled "Developing the Context-Aware Multimodal Ecological Research and Assessment (CAMERA) Platform for Continuous Measurement and Prediction of Anxiety and Memory State."

Umer Hassan received an ONR Grant for the project titled "CNS-Oxygen Toxicity Drug Discovery (OTDD) Therapeutic Platform for Divers."

Ivan Seskar received an NTIA Grant for the consortium named "the Acceleration of Compatibility and Commercialization for Open RAN Deployments (ACCoRD)."

Zhao Zhang, **Bo Yuan**, and **Hang Liu** received an NSF Grant for the project titled "hpcGPT: Enhancing Computing Center User Support with HPC-enriched Generative AI."

Yingying Chen received an NSF Grant for the project titled "Securing Public Safety with WiFi-based In-baggage Suspicious Object Detection."

Yingying Chen received an ARO Grant for the project titled "Enabling Reliable and Adaptive AI on Security-Critical Applications by Handling Out-of-distribution Data."

Yingying Chen received an NSF Grant for the project titled "Education on Securing AI System under Adversarial Machine Learning Attacks."

Aggelos Bletsas, **Narayan Mandayam**, and **Ivan Seskar** received an NSF Grant for the project titled "EFFICIENT: Backscatter Fabric for Multi-dimensional Spectrum Situational Awareness and Protection."

Dipankar Raychaudhuri and **Ivan Seskar** received an NSF Grant for the project titled "Collaborative Research: NewSpectrum: Track 1: Distributed Data-Driven Spectrum Management Architecture for the Next Era of Wireless."

Salim El Rouayheb received an ARL Grant for the project titled "DAST: Dynamic, Adaptive, and Swift AI at the Resource-Constrained Tactical Networks."

Sheng Wei and **Bo Yuan** received an NSF Grant for the project titled "Towards the Security of Immersive Multimedia Systems."

(CvPU) for Convolutional NN-based processing (Anjum and Pompili, IEEE MASS [2023]).

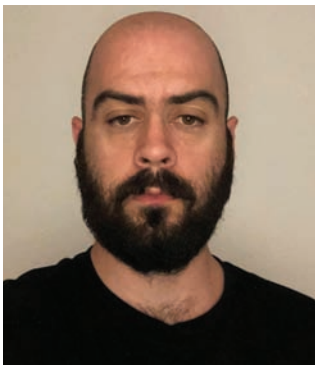
Figure 1 illustrates our case study on Electroencephalogram (EEG) sensing. The helmet's embedded circuits use real-time supervised ML for data processing, powered by harvested energy (e.g., vibration). We employ AJSCC to compress incoming signals, reducing computational load. An embedded all-analog NN (hence power efficient, consuming ~tens of microWatts)–either FNN or CvPU array–detects anomalies that trigger higher-order decision-making processes on a digital cluster head. The FNN architecture utilizes sequential fully-connected hidden layers and benefits from a Voltage-based Resistive-Programmable Unit (VRPU) (Hsieh et al., IEEE MASS [2021]) for multiplication and an OpAmp-based voltage adder for addition. CvPU employs anisotropic diffusion for convolution, using a lattice of passive elements to control interactions, allowing for convolution with arbitrary kernels.

With our current capabilities, we have demonstrated the ability to analyze EEG signals in a spatio-temporal fashion, as shown in Figure 2, using embedded analog NN. As we move forward, we plan to build upon these existing architectures to develop more sophisticated brain-inspired processing techniques (where the NN links connecting the neurons will resemble the three different types of human synapsis, whose behavior is context specific and highly selective in time and space).

To achieve our ambitious objectives, we have a multi-step plan in place. Initially, we will focus on building and validating prototypes of the circuits we have proposed. Following this, we will conduct specialized studies to investigate how AI techniques can be applied to address various physiological phenomena, with the aim of tailoring algorithms for specific health conditions. In parallel, we will work on developing advanced multi-modal fusion techniques to enable an integrated analysis of physiological data. Finally, we are committed to staying at the forefront by consistently proposing and developing new circuits optimized for AI-based computation. All these research activities will be conducted in consultation with Rutgers neuroscientists and medical experts for data interpretation.

Impact. Wearable and implantable devices, enhanced by our proposed real-time monitoring and processing approaches, will revolutionize individuals' ability to manage their health proactively. This technology will not only promote a culture of self-care and wellness but also democratize healthcare by making reliable monitoring accessible, especially in remote and underserved areas. Beyond its immediate healthcare applications, our research has the potential to drive innovation in fields like advanced neurosciences and behavioral sciences by providing unadulterated data-collection capabilities in-the-wild. Our approach will generalize to enable many other applications.

Meet an ECE Student



Spilios Evmorfos

Spilios is from Marousi, Greece, a small town in the northern suburbs of Athens. He completed his undergraduate studies at the ECE school of the National Technical University of Athens in 2018. Following his graduation, he worked as a research assistant at the Institute of Communication and Computer Systems on topics related to machine learning. Since 2020, Spilios has been pursuing a PhD degree with the ECE department at Rutgers, the State University of New Jersey under the supervision of Professor Athina Petropulu. His research lies at the intersection of machine learning, AI and wireless systems.

During the summers of 2022 and 2023, he interned as a research scientist at Siemens Technology in Princeton, NJ, where he worked on deep reinforcement learning. In 2023, Spilios received the best student paper award at the IEEE Workshop on Machine Learning for Signal Processing for his co-authored work with Professor Petropulu and Dr Zhaoyi Xu on generative AI for sensor selection.

Currently, Spilios is working as a Machine Learning Engineering intern at Meta in Menlo Park, California, on AI for modern recommendation systems.

Josh Green

Hello. My name is Joshua, and I am a senior majoring in Electrical and Computer Engineering. I am also the current Internal Vice President of a student organization called Rutgers IEEE.

When I was first entering college, I knew I wanted to study electrical engineering, but didn't know what specific field within electrical engineering I wanted to focus on. I knew what I enjoyed working on, but didn't know what I wanted to spend most of my life working on. I spent most of that year exploring all of the fields that electrical and computer engineering had to offer, but it wasn't until my junior year where I would be able to describe to someone else what exactly I wanted to do.

During my sophomore year, I joined the micromouse division within Rutgers IEEE. Micromouse is a competition where teams build small robots that race to navigate mazes. During my time with micromouse I got to work with microcontrollers and sensors, and also make schematics and PCB layouts for the robots. My time with micromouse convinced me to focus my studies on hardware and systems, but I still wasn't exactly sure where I saw myself after college.

The year after, I decided to become more involved with Rutgers IEEE. At the start of my junior year, I was elected the quartermaster at the start of the Fall 2023 semester, and briefly served as the treasurer during the following semester as well. At the end of the Spring 2024 semester, I was elected to my current position of Internal Vice President. Through these various roles, I learned about some important skills, such as budget and resource management. Furthermore, I found fulfillment organizing and helping out with many different events. I helped run two Vex Robotics competitions at Monroe High School, and have helped the ECE department with many of their events, such as Rutgers Day, the Senior Design Capstone Expo, lab tours, and other demonstrations for prospective students.

It was also during my junior year where I decided that I wanted to pursue a masters degree in computer engineering with a focus on embedded systems. I was really enjoying the classes I was taking, and while I found classes like electronic devices and digital electronics interesting, the class I took that convinced me to pursue a masters was embedded systems. I really enjoyed the design challenges that went along with the embedded systems class, and was very excited to learn that there was active research involving embedded systems in machine learning and AI applications.

As I enter my senior year, I have created a new division within Rutgers IEEE that focuses on embedded systems and hardware security. Furthermore, I am actively exploring research that involves embedded systems and hardware design. Overall, I am excited to see where I end up after my senior year and graduate studies.

Meet an ECE Student *(continued)*

Aishwarya Mallikarjun

"The best way to predict the future is to invent it." – Alan Kay

Hi, I'm Aishwarya Mallikarjun, currently on a fascinating journey as an international master's student specializing in Electrical and Computer Engineering at Rutgers University. My academic voyage began at BNM Institute of Technology in Bengaluru, India, where I graduated with a degree in Electrical and Electronics Engineering. One of my notable achievements was leading the "Smart Solar Bench" project, recognized and funded by the Department of Science & Technology, Government of India, and awarded a design patent. This project, along with my role as an Associate Engineer at Harman Connected Services, ignited my passion for innovation and advanced technology. Choosing Rutgers for my Master's in ECE was driven by the university's distinguished reputation and exceptional opportunities. Rutgers ECE is renowned for its pioneering curriculum, state-of-the-art research facilities, and esteemed faculty. The university's commitment to integrating rigorous coursework with practical research experiences is unparalleled. Centres like the Wireless Information Network Laboratory (WINLAB) offer unique research opportunities, and the strategic location near major tech hubs facilitates excellent industry connections. The inclusive and collaborative environment at Rutgers further enriches the learning experience, preparing students to become industry leaders. During my time at Rutgers, several courses and professors have profoundly impacted my academic journey. Professor Yingying Chen's research in Mobile Computing & Sensing, including wireless indoor localization, IoT, and context-aware sensing, deeply inspired me. Her Mobile Embedded Systems and On-Device AI class allowed me to explore these topics further and understand the practical applications of her research. Working alongside Professor Maria Striki as a grading assistant for the Cloud Computing and Big Data class provided me with a profound understanding of the subject and invaluable hands-on experience. Another pivotal experience was learning about Professor Kristin Dana's research project, NRT-FW-HTF: Socially Cognizant Robotics for a Technology Enhanced Society (SOCRATES). This project, focused on developing robotics that are socially aware and can enhance societal functions, motivated me to delve deeper into socially cognizant technology. Furthermore, my role as a grading assistant for Professor Gabriel Zenarosa in the Rutgers Business School enriched my knowledge in Management Information Science and allowed me to build a strong network by interacting with students and professors from diverse disciplines. I also had the opportunity to work alongside the program coordinator, Katie Yu, as a prospective student administrator in the ECE department. This role provided me with a wide exposure to administrative functions and helped me develop valuable interpersonal, organizational, and communication skills. I'm currently interning with Colgate-Palmolive as a Global Tech Intern, working with the Research and Development team. This internship supports projects to drive results in the Global Technology Function in the Global Device Innovation department. My role involves evaluating complex sensors, collecting data, and generating algorithms to achieve high-performance characteristics. Currently, I am focusing on innovations in the Oral Section domain, particularly on enhancing the performance of existing electric toothbrushes for more accurate cleaning. Balancing my academic and personal life as an international master's student requires strategic time management and a holistic approach. I prioritize my academic responsibilities by creating a structured schedule for studying, attending classes, and engaging in research. To maintain a well-rounded lifestyle, I also dedicate time to my personal interests, such as building robots and experimenting with electronic components. These activities provide a creative outlet and enhance my overall learning experience by applying theoretical knowledge in practical ways. This integration keeps me motivated and balanced, ensuring both academic excellence and a fulfilling personal life. After completing my MS, my career goals are centred around contributing to space-related industries and other high-tech sectors. I have always been fascinated by space exploration, and my dream job has been to work with organizations like ISRO. Additionally, I am interested in roles within the aerospace, telecommunications, and defense industries, where the development of advanced electronic and computer engineering technologies plays a crucial role. I am particularly drawn to positions that involve designing and testing electronic systems for spacecraft, satellites, and other high-tech applications. Pursuing my master's degree has been a pivotal decision, allowing me to maximize my skill set and align my career with my passion for innovation. I am eager to apply my expertise in dynamic and cutting-edge environments, helping to push the boundaries of what is possible in space exploration and beyond.

STUDENT News

Nandana Pai

Hello, my name is Nandana and I am a Master's student in the ECE department through the BS/MS program, specializing in Solid State Electronics. I completed my Bachelor's in May with a minor in Computer Science.

I first explored Rutgers School of Engineering (SoE) through The Academy at Rutgers for Girls in Engineering and Technology (TARGET), a summer program for female middle and high school students. I participated for three years and went from not knowing about engineering to feeling confident that this is the career path I would want to pursue due to the endless opportunities. This led me to attend a vocational STEM high school that further solidified my interest and provided hands-on exposure to ECE.

Despite my prior experiences, I entered Rutgers uncertain about which engineering discipline to pursue. I chose ECE for its versatility and wanted to expand on my existing knowledge. The summer after my freshman year, I was a counselor for the TARGET program. I have always been passionate about teaching and loved educating students on ECE through project-based learning. I also worked as a research assistant at the Wireless Information Network Laboratory (WINLAB) on an IoT human-computer interaction project with Dr. Jorge Ortiz. The objective was to use ambient sensing to infer human activity, and I created a user interface to allow for visual analysis of data as well as managed data collection with a Postgres database. I am grateful for these experiences, which reaffirmed my decision to pursue ECE even before I began my major-related courses. Three years later, I had the chance to collaborate with Dr. Ortiz again on my senior capstone project. This project involved developing a hands-free navigation system for visually impaired users. It provided real-time audible feedback using live camera feed to alert users of obstacles in their path.

As an SoE Ambassador, I represented the ECE department in interactions with prospective and admitted students. I have been heavily involved in the program since sophomore year, serving as an advocate for the mission of the School of Engineering in campus tours and outreach events. My role as a department liaison allowed me to work closely with the ECE department to plan and execute lab demos and information sessions. It has been gratifying to share my experiences and be able to influence a student's decision to join Rutgers and major in ECE. During my senior year, I held a leadership position as a senior ambassador where I got to lead the Professional Development Committee. I was responsible to train fellow ambassadors, organize mentoring sessions and networking events, update resources, and provide feedback on performance. I found great satisfaction in supporting the community and the next generation of students.

Since my freshman year, I have been actively involved in the Society of Women Engineers (SWE) on campus. This involvement has not only helped me build lasting friendships and find mentors but has also given me the opportunity to mentor underclassmen. Over the past two years, I have attended the SWE annual national conference, where I received an internship with The Boeing Company. I have spent the past two summers interning with Boeing AvionX as an Electrical Engineering Design and Analysis intern. These summer internships allowed me to discover my interest in circuit design and testing, an area distinct from my previous project and research experiences, including my first internship with L3Harris Technologies as a Software Engineering Intern.

Choosing between an Electrical or Computer Engineering track was initially challenging for me. I opted for Computer Engineering but took full advantage of the flexibility to explore electives in electrical and firmware engineering. One standout course was Analog Electronics with Dr. Laleh Najafizadeh, where I developed my skills in designing and analyzing multistage operational amplifiers. The course's structure, combining theoretical foundations, math-based problem-solving, and practical design using Cadence Virtuoso, was incredibly beneficial. Additionally, I took Embedded Systems with Professor Milton Diaz-Munoz, which introduced me to FPGA boards. This course allowed me to learn VHDL and deepen my understanding of computer architecture, enabling me to build complex combinational and sequential circuits. I have taken advantage of the past four years at Rutgers ECE to explore various specialties within ECE. While I have found hardware design particularly engaging, I am still uncertain about the specific field or industry I want to pursue. I am excited to spend the coming year honing my skills and discovering my true interests to better define my career path.

Mukund Ramakrishnan

ECE undergraduate student Mukund Ramakrishnan won the Chancellor's Research Excellence Award 2024. The Chancellor's Student Leadership Awards honor undergraduate and graduate students who consistently demonstrate collaboration, leadership, and resourcefulness, have a tremendous passion for Rutgers, and go outside their responsibilities to achieve goals. Mukund was an undergraduate student in Prof. Emina Soljanin's group under this year's James J. Slade scholars program.

Faith Johnson

ECE graduate student Faith Johnson won the Chancellor's Leadership Award 2024. This award is given to a graduate student who exemplifies excellence and truly embodies a commitment to leadership and involvement on campus and/or in the community. Faith was under the supervision of Prof. Kristen Dana.

2024 ECE Capstone Expo

We had a very successful ECE Capstone EXPO on April 24, 2024 with 52 teams presenting their capstone projects. A panel of 50 judges from industry and academia joined us to select the top projects. In addition, three special awards (best in research, best in impact, and best in commercialization) were selected.

Speaking with the judges, I would like to report that they were very impressed with the quality of the capstone projects this year! The judges talked very highly about the complexity and innovation of the capstone projects and the enthusiasm with which they were presented. As a result, the judges decided to give awards to the top 15 teams this year instead of the usual top 10. I would like to thank our judges for their effort and time taken from their busy schedules to support our capstone program and celebrating our students' achievements!

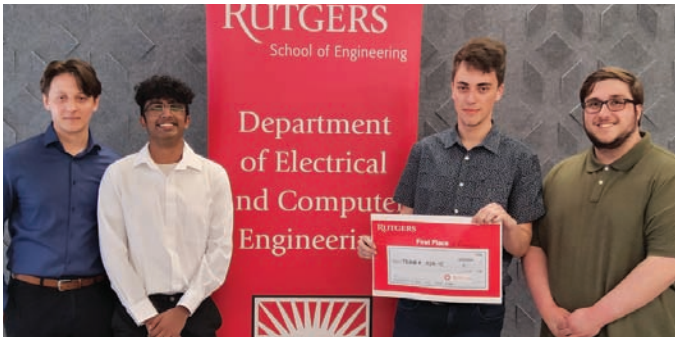
Special thanks to the ECE Staff: Pam, Kevin, John, Arletta, Katie and Chris for helping to make this year's EXPO such a success! This would not have been possible without their hard work and dedication, and months of planning in advance. My special thanks also to **Prof. Demetrios Lambropoulos** who has worked tirelessly from Fall 2023 to help and support the Capstone program. Many thanks also to all the students who volunteered in this event!

I would like to congratulate this year's senior students who participated in the ECE capstone program and their advisors from inside and outside Rutgers ECE who helped guide their projects. Your help and support of our students are essential to the success of the Capstone Program!

I would like to acknowledge the support of the following industry sponsors: **7x24 Exchange Metro New York Chapter, Novo Nordisk, Lockheed Martin and L3Harris.**

Here is the list of award recipients and their advisors:
Top 15 projects and Awardees of Best in Research, Commercialization and Social Impact:

CAPSTONE Expo

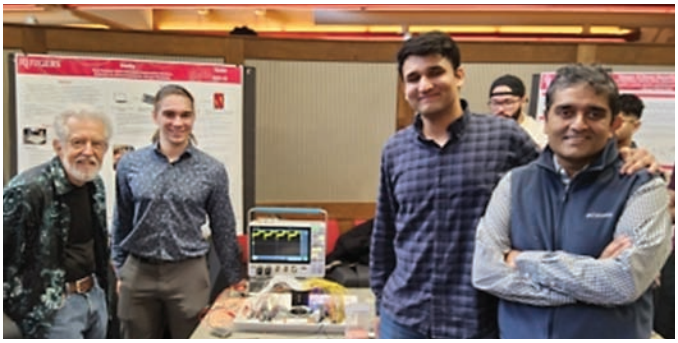


1st Place and Tie in Best in Research Award

Project S24-48: **Radar Based Vital Sign Monitoring with Automated Beam Steering**
Team members: **Daniel Gore, Gavin Young, Felipe Valencia, Daniel Petronchak, Nithish Warren**
Advisor: **Dr. Athina Petropulu**

4th Place

Project S24-24: **Accessible Video Game Controller for One-Handed Individuals**
Team members: **Andrew Chacko, Teerth Patel, Mayank Barad, Georgiy Aleksanyan, Marco Ghabrial**
Advisor: **Dr. Jorge Ortiz**

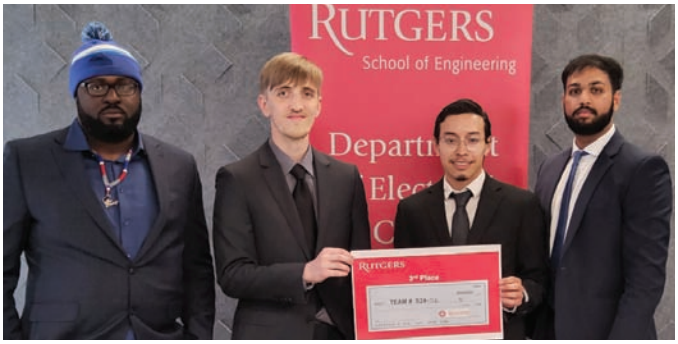


2nd Place and Tie in Best in Research Award

Project S24-41: **Levity**
Team members: **Daniel Maevsky, Yashovardhan Bamalwa**
Advisors: **Dr. Richard Howard** and **Dr. Narayan Mandayam**

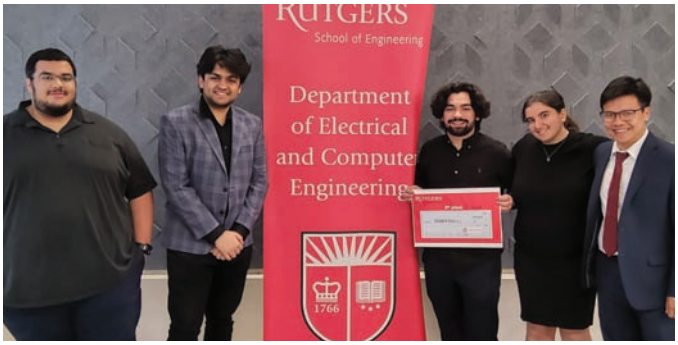
5th Place

Project S24-49: **Cloud-Connected Automation and Optimization for Drones**
Team members: **Ravi Raghavan, Atharva Pandhare, Aryan Patil, Shreyas Ramachandran, Vijay Chandhar**
Advisor: **Dr. Maria Striki**



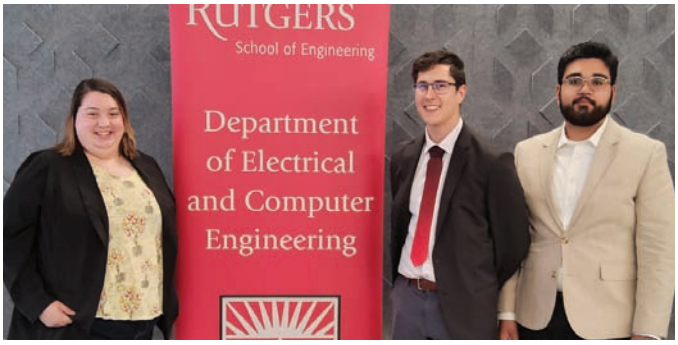
3rd Place

Project S24-02: **RailVision: Overgrowth Detection Drone**
Team members: **Osmin Nolasco, James Sullivan, Steeve Cantave, Dhruv Patel**
Advisors: **Dr. Daniel Burbano Lombana & Dr. Sasan Haghani**



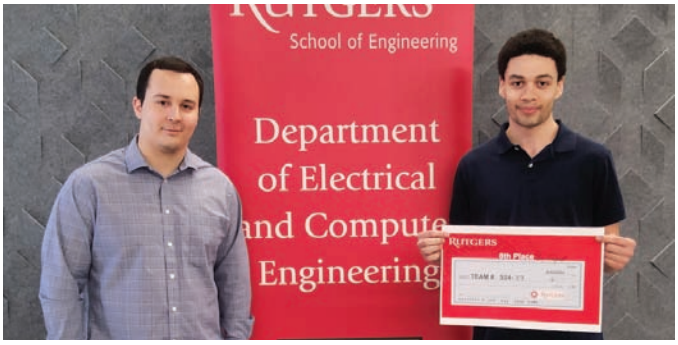
6th Place Tie and Tie in Best in Social Impact

Project S24-07: **RINSIGHT - Real-time Interactive Neural Sensory Integration Glasses for Hearing Technology**
Team members: **William Ching, Jonathan Romero, Aliza Ezrapour, Aman Saxena, Matthew Gravatt**
Advisor: **Dr. Sheng Wei**



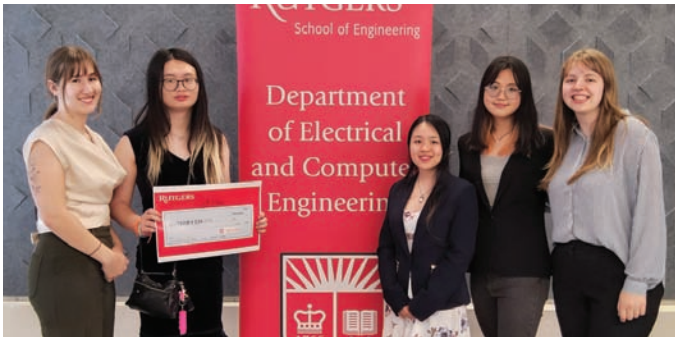
6th Place Tie and Best in Commercialization

Project S24-32: **BlazeGuard : An Automated Fire Prevention Plug for Electronics and Appliances**
Team members: **Devesh Kaloty, Jason Peake, Taylor Scheuering**
Advisor: **Dr. Sasan Haghani and Don Bachman**



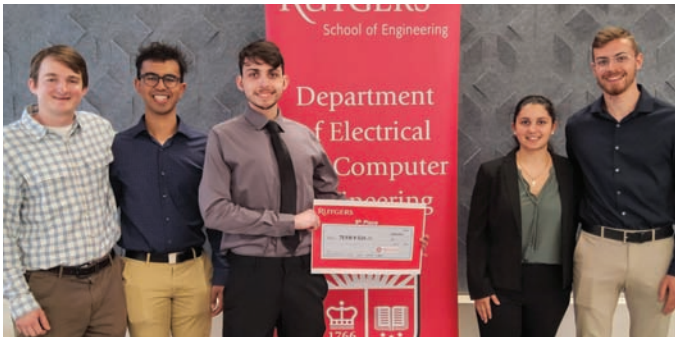
8th Place and Tie in Best Social Impact

Project S24-37: **Human Motion Estimation for Interactive Rehabilitation**
Team members: **Ronan John, Daniel Gameiro, Marco Garcia-Palma**
Advisor: **Dr. Daniel Burbano Lombana**



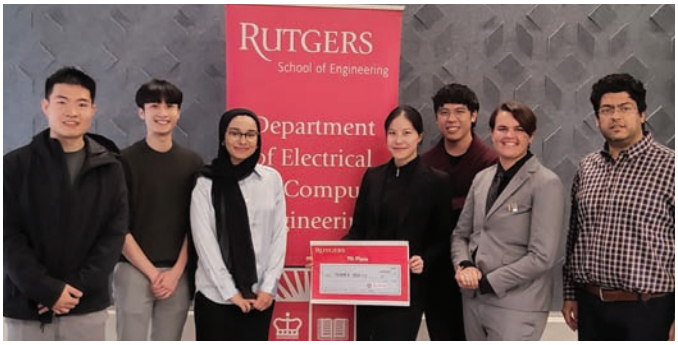
6th Place Tie

Project S24-54: **HomeBud: Small-Scale Smart Watering System for Indoor Plants**
Team members: **Kasey Tian, Izabela Bigos, Victoria Chen, Kristina Jokic, Billie Liang**
Advisor: **Dr. Sasan Haghani**



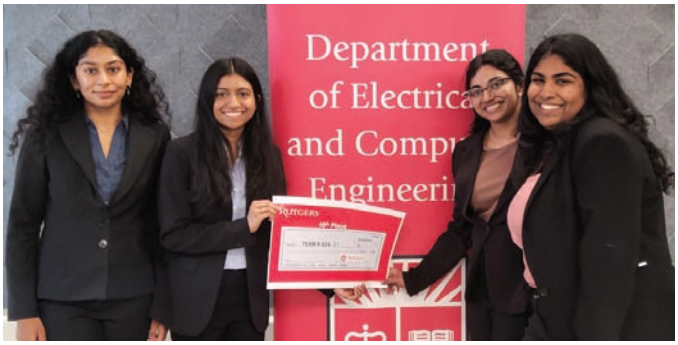
9th Place

Project S24-10: **Design and Application of a Battery Management System for a Formula-Style Car**
Team members: **Mukund Ramakrishnan, Dana Fabiano, Ryan Billings, Thomas Troy Forzani, Daniel McCormack**
Advisor: **Dr. Michael Caggiano**



7th Place

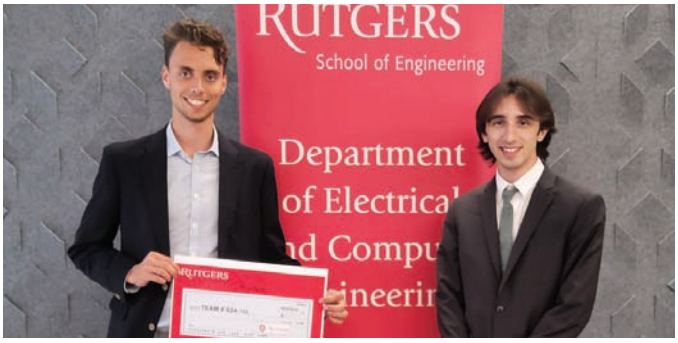
Project S24-27: **Cascaded-UNet: Medical Image Security Enhancement Through AI-Powered Digital Watermarking and Visual Cryptography**
Team members: **Fiona Wang, Zachary Asis, Yesmina Hammouda, Irina Mukhametzhanova, Thomas Trieu**
Advisor: **Dr. Dario Pompili and Tingcong Jiang**



10th Place

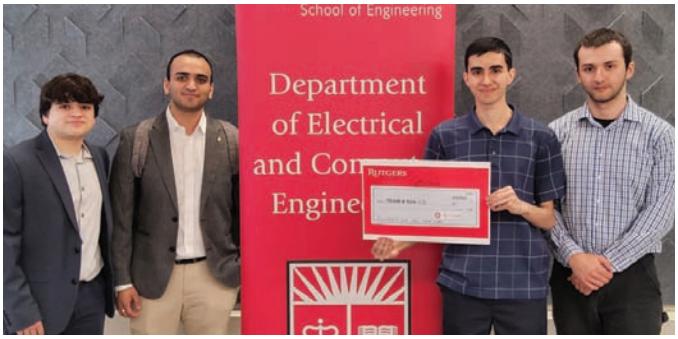
Project S24-31: **SensoryNav**
Team members: **Ramya Ramabhadran, Raveena Gupta, Hima Nukala, Nandana Pai**
Advisor: **Dr. Jorge Ortiz**

CAPSTONE Expo

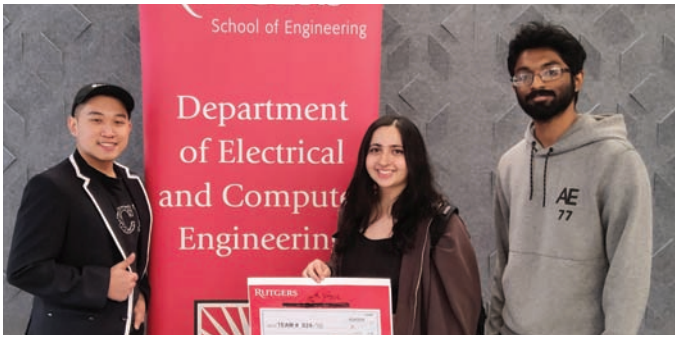


11th Place
Project S24-42: **Hand ANalyzed Dynamics**
Team members: **Samuel Marran, James Artuso**
Advisor: **Dr. Sasan Haghani**

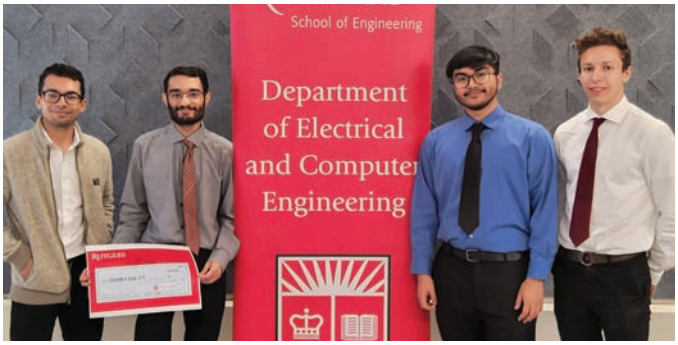
14th Place
Project S24-08: **Ten(Sen)sor**
Team members: **Gurveer Grewal, Danial Fahim**
Advisor: **Demetrios Lambropoulos**



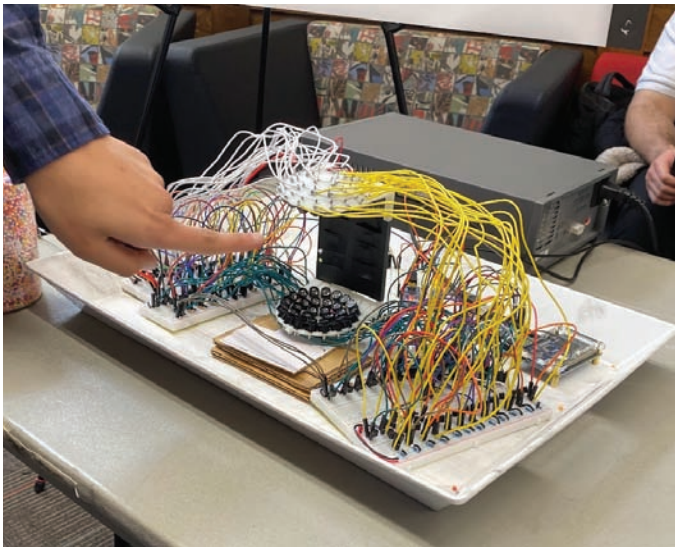
12th Place
Project S24-03: **Drone-Assisted Replication Training**
Team members: **Jinam Modasiya, Aaron Yagudaev, Keyur Rana, Ryan Meegan, Sean Maniar**
Advisor: **Dr. Laleh Najafizadeh** and **Dr. Laurent Burlion**



15th Place
Project S24-46: **Mini Busch Car**
Team members: **Aarushi Vashistha, Abraham Weitzman, Akash Gadicherla, Maanas Gopi, Peter Tran**
Advisor: **Dr. Sasan Haghani, Demetrios Lambropoulos & Jingang Yi**



13th Place
Project S24-29: **Autonomous Parking Lot Navigation for Self-Driving Model Car**
Team members: **Oliver Rzepecki, Vraj Panchal, Isaiah Pajaro, Ryan Elizondo-Fallas**
Advisor: **Dr. Hang Liu**



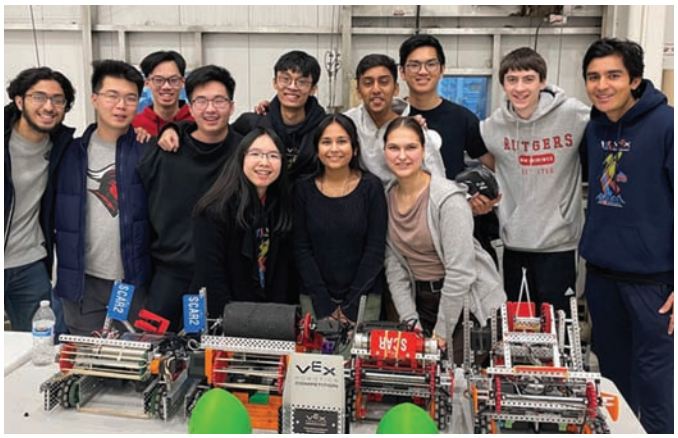
Interactive Intro to Engineering in Fall 2023

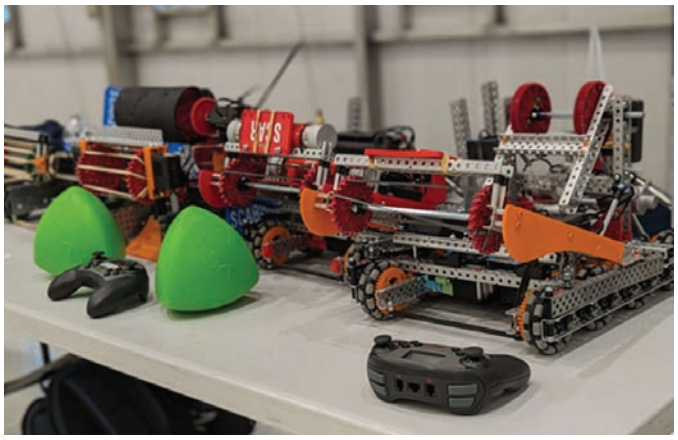
During the week of November 6 to 10, 2023, the ECE Department hosted about 900 undergraduate freshman students in 42 personalized sessions to teach them about the differences between electrical and computer engineering, the ECE curriculum, research in ECE, IEEE, career opportunities available in electrical and computer engineering fields, and the ECE BS/MS program. The goal of Intro to Engineering is to build rapport with freshmen who already decided on an ECE major, bring more interest to SOE students who don't know much about ECE, and gently persuade undecided freshmen to choose ECE as their major. They heard from faculty and staff and had the opportunity to apply what they learned in an ECE pumpkin printed circuit board (PCB)soldering activity.

We look forward to our incoming class of ECE students in the Fall of 2024!

Rutgers IEEE SCAR team won the Tournament Champions award at VCAT VEXU Tournament 2024

On February 3, 2024, Rutgers' IEEE VEXU division recently went to Vaughn College in New York City to compete against 6 other teams. The Rutgers SCAR team placed first and won home the Tournament Champions award! Congratulations to all the members that competed and thank you to Vaughn college for hosting the event.



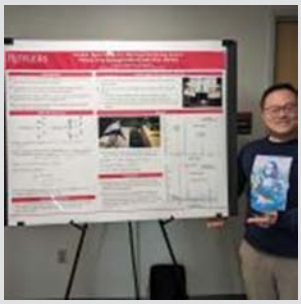


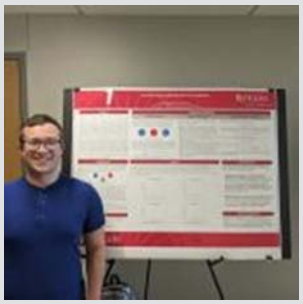
Research Day 2023

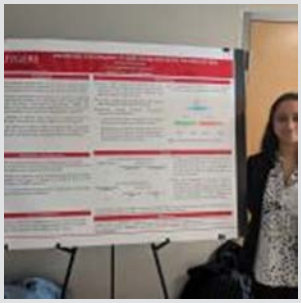
On Friday, December 8, 2023, the annual ECE Research Day was held. This event was an excellent opportunity for ECE students to present their research projects, share their creative ideas, and network with their peers. More than 20 posters were presented by graduate and undergraduate students, covering a diverse range of research topics. Also, six Fall 2024 Capstone teams had a chance to showcase their senior design project:

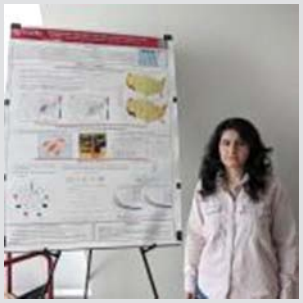
- Team# F23-01 - H.A.R.V.E.Y Harvesting Acceleration Robot for Vegetation Enhancement and Yielding advised by Prof. Sheng Wei
- Team# F23-02 - Smart Fridge Mobile App advised by Anand Sarwate
- Team# F23-03 - Wake-Up Wearable: Stopping Accidents Caused by Falling Asleep advised by Prof. Michael Caggiano
- Team# F23-03 - RU (AI)advisor advised by Prof. Shiring Jalali
- Tean# F23-06 - Optimized Solar-Powered Base Stations: A Simulation-Based Theoretical Framework advised by Prof. Dipankar Raychaudhuri and Ivan Seskar
- Team# F23-07 - Intra-Body Communication: Wireless Direct Contact Communication advised by Dr. Umer Hassan

The event was well-received by faculty, students, and industry representatives. Special thanks to Prof. Laleh Najafizadeh and Prof. Yao Liu for coordinating this important event that showcases the exciting research in our department!



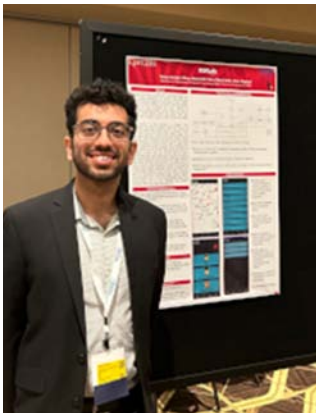


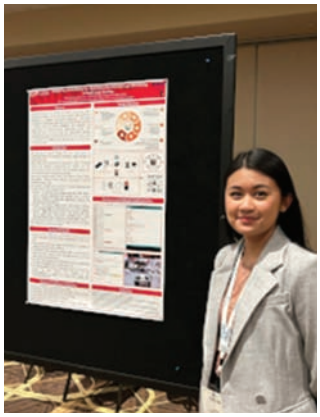




Rutgers ECE at ICCE 2024!

A team of 5 students (**Rohan Gorajia**, **Erwei He**, **Olivia Doung**, **Surabhi Panda**, and **Arpan Gupta**) and 2 Rutgers ECE Professors (**Haghani** and **Striki**) presented 6 papers at the 42nd IEEE International Conference on Consumer Electronics (ICCE) in January 2024 in Las Vegas, NV. ICCE is the IEEE Consumer Technology Society's annual flagship conference. The papers are the results of our students' capstone projects advised by Professors **Daniel Burbano Lombana**, **Maria Striki**, **Demetrios Lambropoulos** and **Sasan Haghani**.





Here is the list of the papers.

[1] E. He, Z. Liu, and S. Haghani, "Design and Implementation of a Smart Rain Barrel Network via the Blynk IoT Platform," to appear in the Proc. of IEEE 42nd International Conference on Consumer Electronics (ICCE), Las Vegas, NV, USA, Jan. 2024.

[2] O. Duong, J. Carew, J. Rea, S. Haghani and M. Striki, "A Multi-Functional Drone for Agriculture Maintenance and Monitoring in Small-Scale Farming," to appear in the Proc. of IEEE 42nd International Conference on Consumer Electronics (ICCE), Las Vegas, NV, USA, Jan. 2024.

[3] R. Gorajia, A. Perez, N. Lluen, M. Striki and S. Haghani, "RUSafe: An Interactive Platform to Enhance Crime Alert Systems on University Campuses," to appear in the Proc. of IEEE 42nd International Conference on Consumer Electronics (ICCE), Las Vegas, NV, USA, Jan. 2024.

[4] W. Gou, D. Banyamin, M. Rezk, W. Fedorowait, D. Burbano, and S. Haghani, "The LanternPredator: A Machine-Learning-Based Robot for Controlling the Spread of Invasive Species," to appear in the Proc. of IEEE 42nd International Conference on Consumer Electronics (ICCE), Las Vegas, NV, USA, Jan. 2024.

[5] A. Gupta, M. Irving, A. Karakoti, J. Canvari, and S. Haghani, "Early Alzheimer's Detection Through VOC Analysis: A Novel Device Approach," to appear in the Proc. of IEEE 42nd International Conference on Consumer Electronics (ICCE), Las Vegas, NV, USA, Jan. 2024.

[6] S. Panda, A. Akbar, O. T. Khan, C. Li, R. Patel, J. Canevari, D. Lambropoulos, and S. Haghani, "A Digital Platform for Early Detection and Monitoring the Progression of Alzheimer's Disease", to appear in the Proc. of IEEE 42nd International Conference on Consumer Electronics (ICCE), Las Vegas, NV, USA, Jan. 2024

Faith Johnson selected as speaker to the Future Leaders in Robotics and AI: Celebrating Diversity and Innovation Seminar Series

The Maryland Robotics Center at the University of Maryland, in partnership with the Microsoft Robotics and Diversity Initiative, has selected ECE graduate student and Rutgers SOCRATES fellow Faith Johnson as a speaker to the *Future Leaders in Robotics and AI: Celebrating Diversity and Innovation Seminar Series.*

Third Rutgers Robotics Workshop 2023

The Third Annual Rutgers Robotics Workshop was held on September 22, 2023, at 33 Livingston Ave., Edward J. Bloustein School of Planning and Public Policy. This interdisciplinary event brings together faculty, students from three schools (School of Engineering, School of Arts and Science, Bloustein) as well as industry representatives. The workshop is part of the NSF National Research Traineeship **SOCRATES** (*Socially Cognizant Robotics for a Technology Enhanced Society*), a cross-disciplinary training program aimed at establishing methods for effective collaboration among researchers from engineering, computer science, psychology, and public-policy and planning with the goal of designing socially-cognizant robotic systems. SOCRATES core faculty include Kristin Dana (PI, ECE), Clint Andrews (Bloustein), Kostas Bekris (CS), Jacob Feldman (Psychology), Jingang Yi (MAE), Pernille Hemmer (Psychology), Aaron Mazzeo (MAE), Hal Salzman (Bloustein), and Matthew Stone (CS).

The workshop began with opening remarks from Prabhas V. Moghe, Executive Vice President for Academic Affairs at Rutgers. A morning panel was held on "*Robots in the age of ChatGPT*". Graduate students from across five departments presented posters on their research during a poster session. Undergraduate students also participated in the day's activities. Industry Representatives from SRI, Latent AI, Siemens Healthineers participated in the panel discussion. Dean Stuart Shapiro gave a welcome address and also in the afternoon panel on "New Robot Technologies and the Social Impact". Prof. Ron Arkin from Georgia Tech gave the keynote address entitled "*Civilized Collaboration: Ethical architectures for enforcing legal requirements and mediating social norms in Human-robot Interaction*". The workshop wrapped up with a tour of the CS Robotics Research Lab.

For more information on the SOCRATES NRT, **robotics.cs.rutgers.edu**

Rutgers Joins NTIA Consortium to Lead the Next Generation of Wireless Network Innovation

By Diane Reed

As the wireless revolution continues to deliver higher networking speeds, more consistent connections, and increased capacity, the need for seamless integration of wireless technologies couldn't be greater. As part of the Department of Commerce's $1.5 billion **Wireless Innovation Fund**, the **National Telecommunications and Information Administration** (NTIA) recently announced $42 million in a new round of grants to support the development of open and interoperable wireless networks. The NTIA anticipates this investment will yield a stronger, more secure and more resilient telecommunications supply chain, enabling the U.S. and its global partners to lead the next generation of wireless innovation.

According to the announcement, **AT&T** and Verizon will head a diverse consortium of U.S. carriers, foreign carriers, universities and equipment suppliers with a goal of catalyzing the global adoption of interoperable infrastructure in wireless networks. Rutgers University's Wireless Information Network Laboratory (WINLAB) is among those joining the Acceleration of Compatibility and Commercialization for Open RAN Deployments (ACCoRD) consortium and will conduct testing, evaluation and certification of O-RAN equipment.

"Rutgers School of Engineering's WINLAB is excited to be a strategic partner on the NTIA's ACCoRD effort," says Ivan Seskar, chief technology officer for WINLAB. "As one of the few O-RAN Test and Integration Centers (OTIC) in North America, WINLAB will leverage its specialized capabilities in prototyping and preliminary testing of wireless technologies, in supporting the broader team's ability to innovate and deploy the next generation of wireless products."

Rutgers, along with Columbia University and NYU, oversees COSMOS, a proving ground for new generations of wireless technologies and applications. The open-access COSMOS platform was initially established in 2018 under the National Science Foundation (NSF) Platforms for Advanced Wireless Research (PAWR) initiative and allows researchers to test advanced wireless techniques for improving network performance and creating city-focused applications.

"The NSF PAWR COSMOS testbed that has been deployed in West Harlem in collaboration with Rutgers and NYU will provide a unique test environment for ACCoRD. Specifically, the focus on ultra-high bandwidth and low latency wireless communication tightly coupled with edge computing and optical x-haul in a dense urban area will enable us to push the envelope in wireless networking," says Gil Zussman, professor of electrical engineering and member of the Data Science Institute at Columbia University.

"Relationships between universities, government, and industry are an important means by which the U.S. can foster innovation, drive economic growth, and solve emerging societal problems," says Narayan Mandayam, WINLAB director and a distinguished professor in the Rutgers School of Engineering's Department of Electrical and Computer Engineering. "We are pleased to contribute to this important consortium, ensuring future wireless products meet the highest standards of efficiency and reliability."

ECE Department Celebrates Successful Renewal of ABET Accreditation

The department has successfully met the Accreditation Board for Engineering and Technology (ABET) criteria once again. This achievement reflects the department's commitment to continuous improvement and excellence in engineering education. The department adopts the ABET Student Outcomes (SOs), which encompass essential competencies for engineering students, including:

- SO1: identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics (Math/Science/Engineering/Problem Solving)
- SO2: apply engineering design to produce solutions that meet the needs of public health, safety, and welfare, and global, cultural, social, environmental, and economic factors (Design)
- SO3: communicate effectively with audiences (Communication)
- SO4: recognize ethical and professional responsibilities in engineering situations and make informed judgments, considering the impact of engineering solutions in global, economic, environmental, and societal contexts (Ethics)
- SO5: create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives (Team and Project Management)
- SO6: develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions (Experiments/Data Analysis)
- SO7: acquire and apply new knowledge as needed, using appropriate learning strategies (Lifelong Learning).

The department formed a dedicated ABET Committee to develop a more robust and detailed Key Performance Indicator (KPI)-based assessment process. The committee, chaired by Dr. Laleh Najafizadeh, includes members Dr. Sasan Haghani, Dr. Dov Kruger, Dr. Hang Liu, Dr. Yao Liu, Dr. Maria Striki, Dr. Sheng Wei, Dr. Yuqian Zhang, Pamela Heinold, Arletta Hoscilowicz, John Scafidi, and Kevin Wine. Their dedication is evident through regular meetings to evaluate the attainment of student outcomes, identify areas needing improvement, and present findings during faculty discussions.

We also want to extend special thanks to the individuals who participated in the interviews with the ABET evaluation team, as their contributions were critical to this success. The department chair, Dr. Yingying Chen, along with ABET coordinator Dr. Laleh Najafizadeh and Undergraduate Director Dr. Sasan Haghani, provided key insights and leadership during the meetings. Other contributors included Dr. Uli Kremer, who engaged with support departments, and faculty members Dr. Hang Liu, Dr. Shirin Jalali, Dr. Dov Kruger, Dr. Sheng Wei, Dr. Athina Petropulu, Dr. Kristin Dana, and Dr. Yao Liu, who represented the program in various discussions. Students, including Shreya Pandey (President, IEEE Student Chapter) and Rishab Patel (Vice President, 7x24 Exchange Student Chapter), along with representatives from SWE and IEEE, contributed valuable perspectives during the luncheon and student group sessions. The advisory board, represented by Don Bachman, also played a vital role. Their efforts and dedication were instrumental in demonstrating the department's excellence to the ABET evaluation team. This achievement highlights the department's strong commitment to providing students with high-quality education that meets global standards.

2024 WINLAB Summer Internship: Advancing Research and Innovation in Wireless Technology

This year's WINLAB summer internship program concluded on August 7th with a two part open house. This internship was the largest in WINLAB's history, with 70 participants, including undergraduates, graduate students and high school students. The cohort of interns this year included students from universities all over the United States, as well as two students from the National Technical University of Athens and one student from the Technical University of Crete.

This year's program received very generous support from the National Science Foundation, (continued sponsor) nVerses Capital, Verizon, AT&T, and Rutgers School of Engineering, without which the internship would not have been possible. Many of the interns were funded through the NSF Research Experience for Undergraduates program, which allowed them to work on existing WINLAB research initiatives related to topics such as FR3 spectrum, weather interference with millimeter wave signals, and machine learning models for edge cloud architectures. Several projects, such as the **AR Mural** project and the **Self-Driving Vehicular** project, focused on applications for low-latency high-bandwidth 5G networks. This was the second year that the internship program received a donation from nVerses Capital-- thanks to their support, the internship was able to fund several new projects as well as devote more resources to educational content for the interns.

Five Rutgers students were directly sponsored by Verizon to work on the **5G Edge Cloud** project, which focused on the ways in which 5G networks could facilitate smart intersection and traffic management algorithms of the future. The students used the traffic simulator SUMO along with CARLA, a simulator meant for developing autonomous vehicle algorithms. These open-source simulators were used along with a publisher-subscriber message broker to create a framework that could model realistic traffic scenarios and introduce simulated network conditions to measure the impact on various vehicle behavior algorithms.

Two groups were funded by Rutgers New Brunswick and supervised directly by Dr. Wade Trappe, Associate Dean for Research and Development. The aim of these projects was to use commodity augmented reality and virtual reality systems to visualize complex scientific data. Three students worked on the **Underwater UAV Visualization** project, in which a VR headset was used to view data recorded by the underwater autonomous vehicles in the Rutgers Glider program. The students developed a program that would replay data traces recorded by the glider so that they could be seen in the headset from the perspective of the glider. The students had the opportunity to visit the Rutgers glider lab and talk to the researchers working with the glider data to find out how best to develop the visualization tools.

Another three students worked on a project to visualize protein models using an augmented reality headset. These students learned how to work with common protein data formats and developed a utility that would allow someone wearing the headset to load, visualize and manipulate the protein models in space. Over the course of the summer, they had to solve many technical problems associated with loading and visualizing very large data files.

New ECE professor Dr. Aggelos Bletsas supervised three projects using RFID backscattering and had this to say about the internship program: *"The value of this is the fact that this place is full of energetic, highly talented undergraduate and graduate students working together and prototyping using software defined radios. Wireless technology is at the core of each project as a means to solve fundamental problems. For the particular case of backscatter radio the projects showcased novel sensing and localization with ultra-low cost, ultra-low power and energy."* Dr. Bletsas supervised the **Magic Room** project which used hundreds of low-cost passive RFID tags to localize people moving in a room, and the **Plant Doctor** project (co-supervised with Dr Richard Howard), which used backscat-

tering to transmit measurements from low-cost sensors; students demonstrated this technology by using custom, ultra-sensitivity leaf temperature sensors to determine when a plant would need to be watered. The third project was **Multistatic RFID Interrogation and Localization with COSMOS/ORBIT** which used software defined radios in the ORBIT testbed to develop algorithms for RFID tag localization with multiple transmitters and receivers.

This year saw the continuation of the **Self-Driving Vehicular Project**. Students this year were able to continue from the work done last summer, letting them take advantage of the existing hardware prototypes and software infrastructure. This allowed the students to focus their time on developing and testing various machine learning models for self driving. The team also created a suite of software tools to help them create and evaluate their models. Brandon Cheng, a senior in the ECE department, returned to the internship to work on the self-driving project for the third year in a row. He commented *"I had a great time this summer gaining first-hand experience working with many different technologies. Through the mentorship provided by WINLAB and the collaboration of our group, we were able to bring our project to life through problem solving and innovation."*

Another long-running project was the **AI for Behavioral Discovery** project, part of a research initiative by Dr. Rich Martin and Dr. Rich Howard to study the effects of RF signals on bees. Students this year applied convolutional neural networks and other machine learning models to the task of labeling real and simulated videos of bees in order to determine if a machine learning algorithm could distinguish between the presence and absence of a magnetic field based solely on the observed behavior of the bees.

One of the new projects this year, funded though the NSF REU program, and supervised by Dr. Narayan Mandayam, was **ORBIT Emulation and Machine Learning for Enabling 5G and Satellite Network Coexistence in FR3 Spectrum**, which used the ORBIT testbed to simulate satellite and 5G signals with the goal of using machine learning to estimate how the signals would interfere with each other over a region of space. Christos Bovolis, a visiting student from the National Technical University of Athens who worked on this project made these remarks about his experience over the summer: *"The project perfectly combined my interests, i.e., digital communication networks and machine learning, but I also used a testbed for the first time, and the whole technical aspect turned out to be quite enjoyable (especially GNU Radio, automating processes with bash scripting etc). WINLAB has world-class projects and collaborations, and indeed ... 'it opened our eyes.' The program came at a very important time, as I will soon be choosing the topic of my thesis and my academic path in general, so it will definitely help me make more informed decisions."*

The inclusion this year of several high-school only projects meant that those projects could be more finely calibrated to the level of experience that the students brought to the program and allowed those projects to place more emphasis on STEM educational content. These projects included the **Remotely Piloted Vehicles** project, lead by Dr. Rich Martin, in which students used RC-style cars to observe the latency of using public internet infrastructure to drive a vehicle remotely. Dr. Martin also supervised the **Breadboard Computer** project, which had high school students build an 8-bit computer on a breadboard from basic components. The **Data Center Infrastructure Management** project, supervised by Alexei Kotelnikov from the School of Engineering, taught a group of high school students how to set up and manage the software required to operate an enterprise computing cluster. Under the supervision of Dr. Jorge Ortiz, students working on the **Smart Sense Testbed** project gained hands-on experience building infrastructure for real-world data collection, essential to Dr. Ortiz's research on using large language models (LLMs) to understand physical spaces, dynamic interactions, and human activity patterns. By developing systems for integrating new devices and setting up backend data management, the students contributed to creating the foundation needed for AI models to interpret complex environments. This project not only advanced the students' engineering skills but also supported Dr. Ortiz's vision of using AI to unlock insights into human behavior and physical interactions in dynamic spaces.

This year's program was widely regarded by the WINLAB staff and faculty as one of the most successful internship programs to date. The students were able to complete meaningful research work

continued on page 32

WINLAB Summer Internship (*continued*)

over the course of the summer, and many of them were able to demonstrate a solid understanding of engineering topics that they hadn't known anything about at the beginning of the summer. This year's open house was an excellent showcase not only of the work that was done over the summer but also of the students themselves, who have become better engineers through the hands-on experiences they had during the program. Dr Rich Howard, who acted as a mentor to many of the students during the summer, said this about the program:

"For me the educational content in this program is the opportunity for students to get out of the world of just writing abstract code and doing abstract math and into the world where they touch real things, not just voltages and currents but rotating wheels and flashing cameras. The abstract world becomes concrete and real. It becomes the bridge to making things happen as opposed to just thinking about things. When you watch the students do this, the enthusiasm that they show is just wonderful to watch. They race vehicles, chase bees and watch flashing lights in a very real computer that is built out of leds and wires. They leave this program with the sense that the real world is something that you can interact with and become part of, that you can control and change, not just problem sets to be ground through in a class."

Undergraduate Researchers, Sean Johnson and Jack Callinan, present at IEEE MILCOM

Third year ECE/WINLAB undergraduate researchers, **Sean Johnson** and **Jack Callinan**, presented their signal detection research as part of the IEEE MILCOM experimental demonstration session. MILCOM is a top-tier military and academic communication annual conference that invites the best of the research in communications. Sean and Jack were the only undergraduates whose work was presented in the session and have impressed many researchers. Their work demonstrates how bandwidth spreading codes can be employed to achieve signal covertness.

Sean and Jack also demonstrated the effectiveness of methods for signal feature detection to identify the presence of covert signals. The novelties of the research includes its use of cyclostationary statistics to identify a spread signal via feature detection and an analysis of novel techniques in encoding to defeat feature detection. Conventionally, a signal is detected using simple energy detection. A method where the average power in a range of frequencies is used as a metric of detection. As part of their demo, Sean and Jack demonstrated that this method is highly vulnerable to attempts to spread the energy over the spectrum. In order to compensate for this vulnerability the demonstration establishes that an adversary could use cyclostationary statistics that relied on finding power at multiple periodicities as a mechanism for signal detection and analysis.

Sean and Jack's findings contribute to a growing body of evidence substantiating that there needs to be further work in the field of signal detection methods outside of the classic detection strategies to remain competitive both in retaining signal covertness from a hostile eavesdropper and in retaining the ability to reliably detect signals. The research is employed as a proof of concept for a testbed developed at Rutgers WINLAB by Professor Predrag Spasojevic's Research Team and funded by an ONR DURIP grant. The research is performed in collaboration with Army Research Laboratory DeVCom Team under the leadership of Dr. Fikadu Dagefu and is a follow-up on research works by Morriel Kasher, Rahul Aggarwal, and Dr. Chryssalenia Kompouzi, doctoral students under the supervision of Professor Spasojevic

WINLAB and Open Network Foundation Team receives an award from the Biden-Harris Administration's Wireless Innovation Fund to improve 5G O-RAN Energy Efficiency

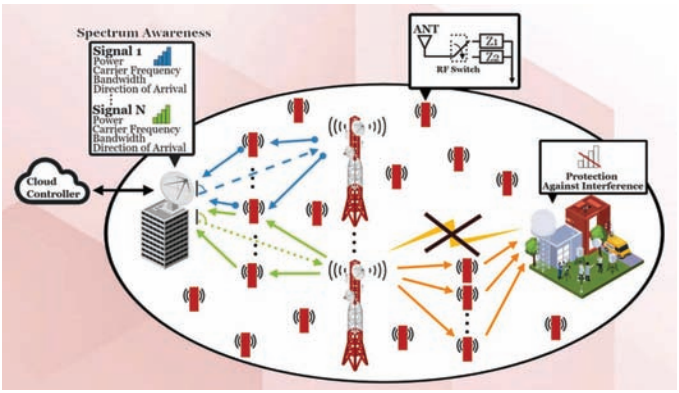
WINLAB in collaboration with the **Open Network Foundation** (ONF) is a recipient of an award for $1.97M announced as part of the second round of awards announced by the Biden-Harris Administration's Wireless Innovation Fund. The $1.5 billion Wireless Innovation Fund supports the development of open and interoperable wireless networks as part of the Biden-Harris Administration's Investing in America agenda. Open and interoperable wireless equipment will help drive competition, strengthen global supply chain resilience and lower costs for consumers and network operators. Please see a press release from the Department of Commerce's National Telecommunications and Information Administration (NTIA) **here**.

WINLAB Chief Technology Officer **Ivan Seskar** is the Rutgers PI for the project titled "5G Energy Efficiency: Metrics, Models, and Systems Tests" and will lead a research team including Dr. N. K. Shankaranarayanan, that funds activities at WINLAB for a period of 2 years at $750k. In partnership with ONF, WINLAB will develop testing methods that assess the energy consumption and efficiency of individual 5G network components and end-to-end Open Radio Access Network (O-RAN) architectures.

A team of WINLAB researchers led by Professor Aggelos Bletsas (PI) along with co-PIs Distinguished Professor Narayan Mandayam (Director, WINLAB) and Ivan Seskar (Chief Technologist, WINLAB), are the recipients of an award from the National Science Foundation under the Next Era of Wireless and Spectrum (NewSpectrum) program for the project "EFFICIENT: Backscatter Fabric for Multidimensional Spectrum Situational Awareness and Protection". This three-year project funded at $800,000 addresses two emerging topics of increasing interest, namely (i) spectrum situational awareness and (ii) protection from interference.

The next era of spectrum is envisioned to have spatially and spectrally adjacent systems that are dynamic, resulting in frequent cross-system interference. Naturally, interference lies at the heart of spectrum sharing and involves a network of radio transceivers, distributed in space with varying behavior over time. Mechanisms used in the current and past eras of spectrum management, have all run up against limitations owing to the cost and potential lack of scalability of such solutions. This project addresses both spectrum situational awareness and protection from interference, exploiting ultra-low complexity radio hardware and non-coherent techniques; the basic idea lies at the heart of backscatter radio, which enables a fabric of low-complexity backscatter tags for said objectives. These tags are controlled through the receiver/gateway, connected to the cloud, without however requiring channel state information (CSI) regarding any of the involved links.

The proposed fabric offers an intelligent, yet low-cost solution with minimal hardware complexity (due to the adopted backscatter radio tags), limited channel state information (due to the proposed non-coherent algorithms), with the capacity to observe signal strength (power), frequencies and direction-of-arrival (DoA) for a set of in-band, simultaneously operating links. Such multidimensional spectrum situational awareness comes with a collateral dividend: interference protection, i.e., the ability to cancel interference at specific receiver locations. Techniques developed include both model-based, as well as data-driven machine learning (ML) approaches. In addition, this work targets demonstration of the proposed principles in the FR3 band, with a particular focus on the 12.2 – 12.7 GHz band, where next generation cellular, digital video broadcasting and low-earth orbit satellite (SAT) radio applications have the potential to coexist. The creation of the backscatter fabric will contribute to the envisioned Spectrum Era 4 and the ever-expanding problem of meeting increasing wireless data demands.



Aggelos Bietsas

Ivan Seskar

Narayan Mandayam

ALUMNI News

Corey Norton

As of April 9, 2024, **Corey Norton** became officially a patented inventor as recognized by the US Patent and Trademark Office. US Patent No. 11,951,476 has been issued for the ESMM biosensor he designed during his graduate studies at Rutgers University under the direction of his research advisor Umer Hassan!

Entrepreneur, innovator, speaker, author, media personality, and DEI expert **Dr. Randal Pinkett** ENG'94 was the keynote speaker at Rutgers School of Engineering's 2024 convocation on May 10, 2024.

Randal Pinkett

Dr. Randal Pinkett is the co-founder, chairman and CEO of **BCT Partners**, a global research, training, consulting, technology and data analytics firm that has been recognized by Inc. 5000 as one of the nation's fastest-growing private companies, and by **Forbes** as a "Best Management Consulting Firm." As a contributor to **MSNBC**, **CNN**, and Fox Business News, his expertise includes areas such as emerging technologies, big data analytics, social innovation, culture, and DEI. An international public speaker, he has authored or co-authored several books such as **Black Faces In High Places Book** and Data-Driven DEI.

He earned his BS in electrical engineering from Rutgers, where he was the captain of the men's track and field team. He was the first African American Rutgers graduate to receive a Rhodes Scholarship to the **University of Oxford**, where he earned a Master of Science degree. He subsequently earned a second MS, an MBA, and a PhD from **Massachusetts Institute of Technology**. He was also a winner of the NBC show "The Apprentice."

"Randal Pinkett's dedication to transforming lives, accelerating equity for all, and promoting lasting business and societal change through diversity, insights, and innovation, embodies the ideals and vision of the School of Engineering," says School of Engineering Dean **Alberto Cuitino**.

Tahsina Saman

Tahsina Saman received the prestigious UNESCO OWSD Early Career Fellowship Award 2023. Only 28 women scientists around the globe has been awarded this Fellowship.

She is officially a Fellow of UNESCO-OWSD and will carry out an exciting research project solving a national yet global challenge using advanced Artificial Intelligence and Wireless Communication technologies in the next couple of years.

ECE Alumni Has Been Elected to NAE

Pete Pupalaikis

ECE alumni **Pete Pupalaikis** has been elected to NAE! We are very excited about the news. Pete is our distinguished alumni and currently serving on the ECE Industry Advisory Board. We are so proud of him! Pete is a great role model for all the engineering students. The following is the summary of Pete's achievements:

My main achievements were in pioneering digital signal processing techniques for the correction of hardware impairments in high-speed digital oscilloscopes, such as magnitude response, phase response, time-interleaving, as well as bandwidth extension. This culminated in my main set of inventions that combine a microwave front-end and a DSP back-end to double and/or triple the state-of-the-art bandwidth possible in oscilloscopes, which led to LeCroy making the highest bandwidth real-time oscilloscopes for over a decade. This technique was used to produce a 100 GHz bandwidth, 240 GS/s scope in 2015. I also pioneered the design and development of time-domain reflectometry (TDR) based network analyzers.

The one sentence summary would be that I pioneered DSP and microwave techniques as applied to high-bandwidth real-time digital oscilloscopes.

If you were interested, some of this technology is explained in this paper: ***https://ieeexplore.ieee.org/document/6981299*** **or** ***https://shorturl.at/wFsZ7***

The ECE Department Wishes to Thank All the Donors Who Supported Us During the Past Year.

For decades, the Department of Electrical and Computer Engineering (ECE) has been home to groundbreaking research and educational practices. Your gift to ECE supports such a tradition; more specifically, it provides the students, faculty, and researchers with the resources they need to continue developing the minds and technology that make our world a better place.

Your Contributions Helped Us

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Thank you!

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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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Founding Partner and Director of Signal Integrity
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Ashwin Sampath
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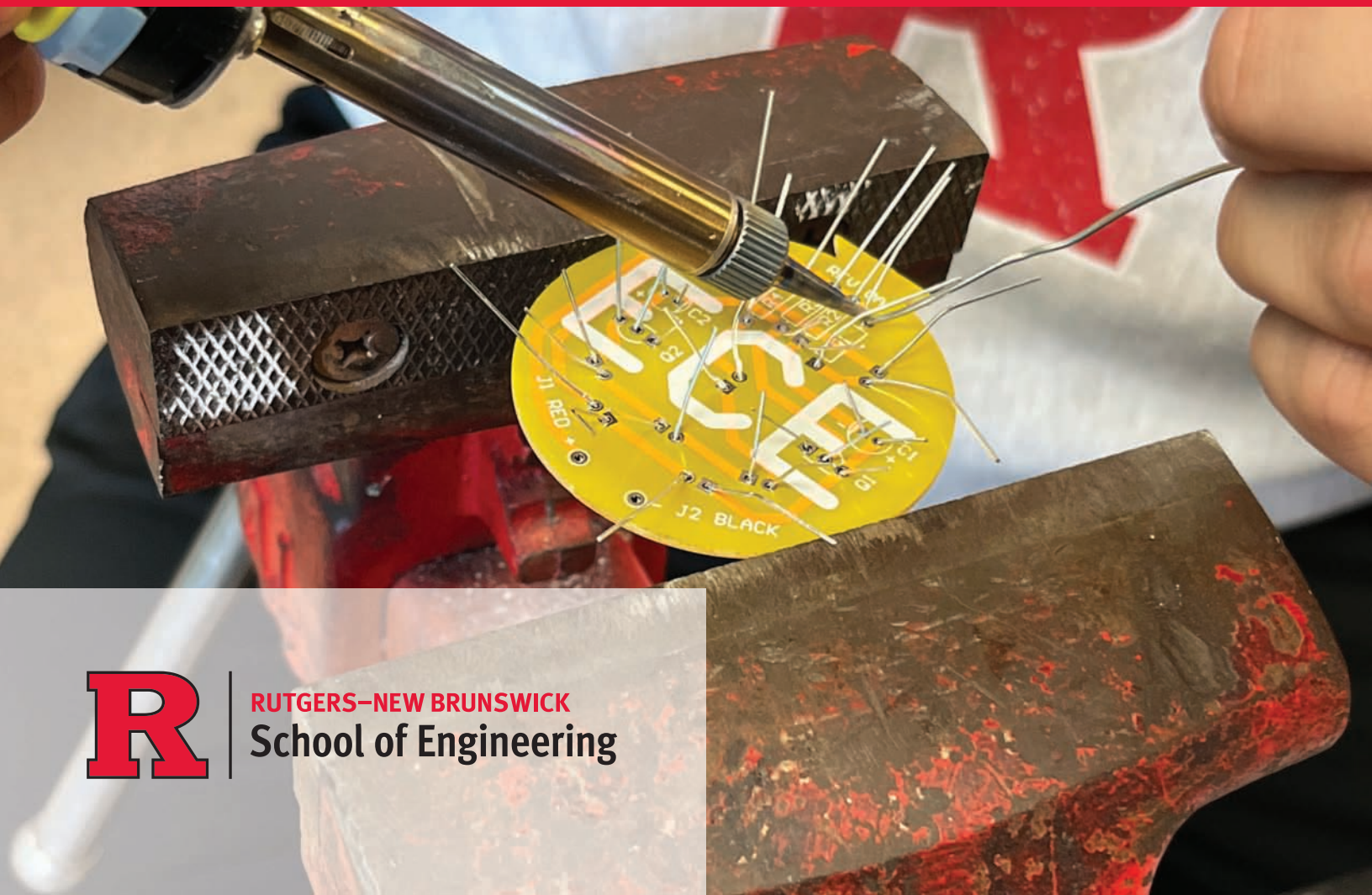

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