NYU WIRELESS

Pulse

FALL 2022 • VOL. 9, NO. 1 • NYUWIRELESS.COM

Featured Articles

NYU WIRELESS
Pulse
FALL 2022 • VOL. 9, NO. 1
NYUWIRELESS.COM

Pat Donohue, Editor
Michelle Austin, Writer
Rebecca Brooke, Senior Copy Editor
Printed by GHP Media

NYU WIRELESS is a vibrant academic research center pushing the boundaries of wireless communications, sensing, networking, and devices.

Centered at NYU Tandon School of Engineering and involving leaders from industry, faculty, and students throughout the entire NYU community, NYU WIRELESS offers its Industrial Affiliates, students, and faculty members a world-class research environment that is creating fundamental knowledge, theories, and techniques for future mass-deployable wireless devices in a wide range of applications and markets.

Every January, NYU WIRELESS hosts an annual Open House for all of its students and Industrial Affiliate Members, followed by the prestigious invitation-only Brooklyn 6G summit (B6GS.com), in cooperation with Nokia Bell Laboratories, for the center's Industrial Affiliates and thought leaders throughout the global telecommunications industry. This year the Summit will be held on October 24–27, 2022, followed by the second NYU WIRELESS Workshop on October 27 & 28.

NYU WIRELESS, info@nyuwireless.com

Leadership Founding Director Ted Rappaport, Director Thomas L. Marzetta, and Associate Directors Sundeep Rangan, John-Ross Rizzo, and Dennis Shasha manage NYU WIRELESS across Brooklyn and Manhattan campuses of NYU. Rappaport has powered the 5G millimeter wave era and is a leading educator in the wireless arena, having authored many books and started two companies and three major academic wireless research centers. Rangan is an Electrical Engineering Professor at NYU Tandon and was a co-founder of Flarion Technologies, which developed Flash-OFDM, one of the first cellular OFDM data systems. Marzetta originated the concept of Massive MIMO and seeks ten-fold improvements over Massive MIMO through a closer union of wave propagation physics and communication theory. Rizzo is an Assistant Professor in the Departments of Rehabilitation Medicine and Neurology at NYU Langone Health. His research is focused on wearable technology and blindness and visual impairment. Shasha of Courant's Computer Science Department is widely known for his expertise in data-intensive algorithms and streaming data and is a highly acclaimed inventor of mathematical puzzles.

The Industrial Affiliates Program NYU WIRELESS invites global companies to join our Industrial Affiliates program. The program offers instant access to cutting-edge research results and talented students in a mutually beneficial relationship among NYU WIRELESS researchers, students, facilities, and leading industry partners. NYU WIRELESS would like to thank our Industrial Affiliate Partners as well as NSF, NIH, and DOD for their continued support. Learn more about our Industrial Affiliates program by visiting nyuwireless.com/industrial-affiliates.

About the cover Sapna Parikh, M.D., M.P.H., is Assistant Director of Visual Storytelling in NYU's University Relations & Public Affairs Department. She is the producer, host, and editor of the research-focused Brainiacs video series, which you can read more about on page 13.

The Impact of Undirected Research

In 2014 I was privileged to take part in the Marconi Society symposium in honor of Stanford University Professor Emeritus Arogyaswami Paulraj. While at the meeting I remember paying particular attention to the words of then FCC Commissioner (now Chairwoman) Jessica Rosenworcel:

> "What if we issued a challenge in Washington? Think of it as Race to the Top, the Spectrum Edition. Imagine that we decided to reward the first person who finds a way to make spectrum use below 5 GHz fifty or a hundred times more efficient over the next decade. The reward could be something simple—say 10 megahertz of spectrum suitable for mobile broadband."

Eight years have passed since then, and 5G Massive MIMO has proven that it can deliver as much as ten times the spectral efficiency of 4G technology. Should Massive MIMO ever be adopted for fixed access, I am confident that we could attain Rosenworcel's goal of making spectrum use fifty times more efficient. One-hundred-twenty-degree sector antennas are going the way of the spark transmitter, replaced by marvelously compact 64- and 128-active-element arrays. Last year, service providers paid $81 billion for 280 MHz of C-band spectrum ($289/Hz!). Massive MIMO multiplies the value of this investment ten-fold. This technological revolution could not have happened without a huge investment by industry and the combined efforts of thousands of engineers. But the concept of Massive MIMO was entirely the product of undirected fundamental research.

I originated the concept of Massive MIMO in 2006 while working in the Mathematical Sciences Research Center of Bell Labs [T. L. Marzetta, "How much training is required for multiuser MIMO?," *40th Asilomar Conference on Signals, Systems, and Computers*]. Even within Bell Labs, the freedom enjoyed by Math Center researchers was considered extraordinary. Regrettably, support for undirected research is increasingly difficult to obtain. Here at NYU WIRELESS, however, we are supremely fortunate to have the backing of our Industrial Affiliate Members, which enables our professors and students to depart from conventional thinking and to undertake bold and risky research. With this continuing support combined with our outside-the-box creative thinking, we look forward to being the discoverers of the next breakthroughs in wireless communications!

Thomas L. Marzetta
Director, NYU WIRELESS

NYU WIRELESS Team among NYU Tandon Researchers Awarded $2.5 Million NSF RINGS Grant

Lightning-fast, low-latency wireless, from 5G to 6G and beyond, will improve such services as virtual and augmented reality streaming, near-zero latency vehicle-to-cloud communications to help self-driving cars navigate in real time, remote surgery, coordination of automated systems in factories and other facilities, and a myriad of other futuristic consumer applications.

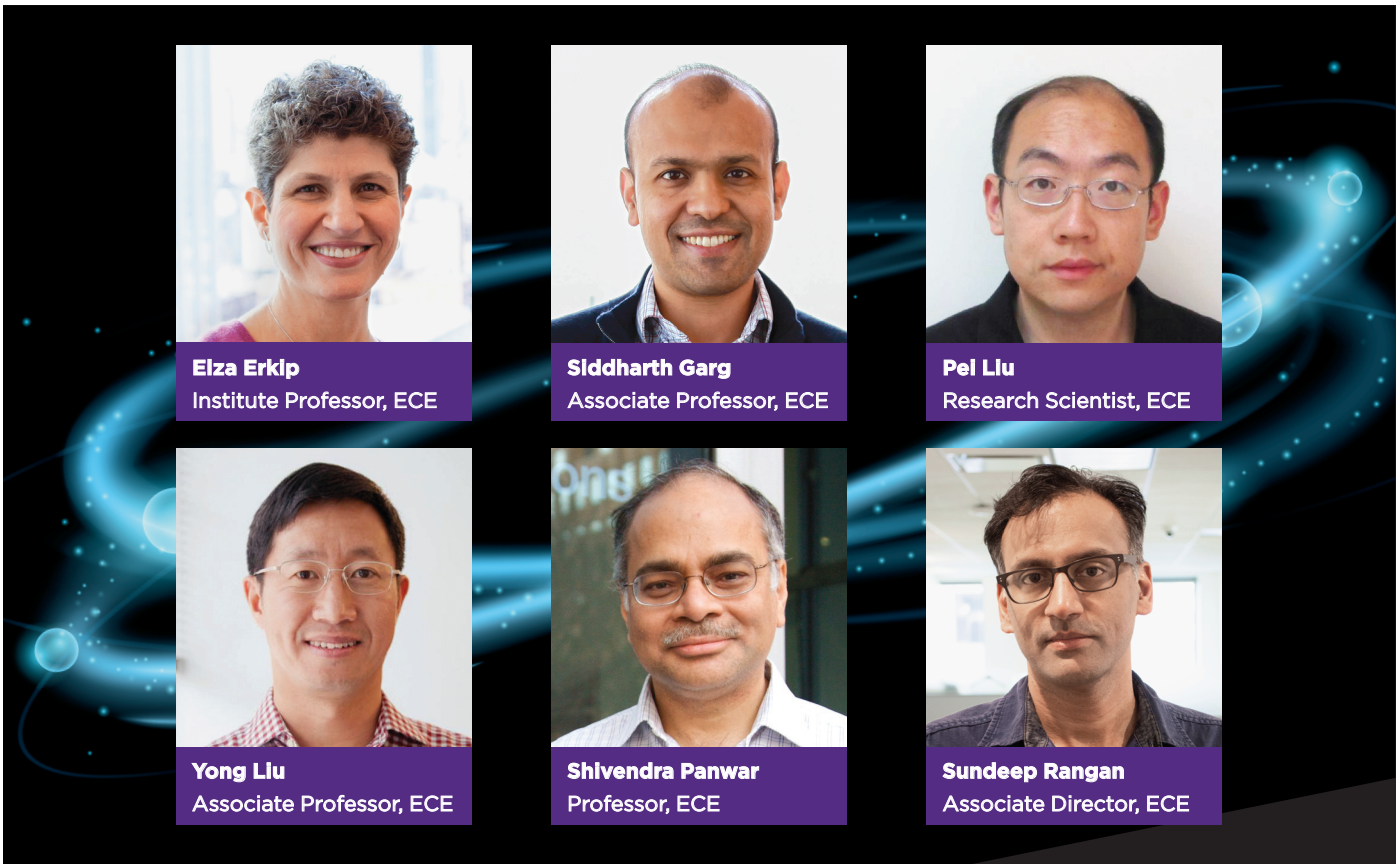
But these benefits come at a cost: Advances in wireless technology will potentially open a Pandora's box of security vulnerabilities in the hardware serving as its backbone and the software driving its networks.

A new National Science Foundation (NSF) initiative has awarded three teams of researchers from the NYU Tandon School of Engineering a combined $2.5 million to confront these challenges head on. Participating in the research, which is supported by NSF's Resilient and Intelligent Next Generation Systems (RINGS) partnership, are NYU WIRELESS' Elza Erkip, Siddharth Garg, Yong Liu, Pei Liu, Shiv Panwar, and Sundeep Rangan. Other NYU Tandon professors from the NYU Center for Cybersecurity and the New York State Center for Advanced Technology in Telecommunications (CATT) are Zhong-Ping Jiang, Farshad Khorrami, and Ramesh Karri. Shiv is also director of CATT, which is sponsored by New York State's Empire State Development's Division of Science, Technology, and Innovation.

Together, the teams will focus on making current and future wireless infrastructure, software, and hardware systems more resilient to flaws, accidents, subterfuge, and hacks. RINGS is a public-private partnership focused on accelerating research to increase the competitiveness of the United States in networking and computing technologies and to ensure the security and resilience of NextG technologies and infrastructure. The partnership includes NYU WIRELESS Industrial Affiliates Ericsson, Nokia, and Qualcomm, as well as Apple, Google, IBM, Intel, Microsoft, and VMware. Government partners include the U.S. Department of Defense's Office of the Under Secretary of Defense for Research and Engineering and the National Institute of Standards and Technology.

Of the RINGS partnership grants awarded to 37 institutions, NYU Tandon was one of only three to receive a trio of them.

U.S. Senator Charles Schumer praised the Tandon teams, noting that "Future generations of wireless communications will enhance our ability to democratize information sharing, but it's important these future services are secure to protect our infrastructure, individuals, and their transactions. I am proud to support the researchers at the NYU Tandon School of Engineering and the three RINGS grants they received from the National Science Foundation



to ensure a safe and secure transition from the current generation of wireless communications."

Explained Sundeep, "Broadly speaking, to 'harden' next-generation telecommunications, we are seeking to understand and rethink the design of wireless networks from the physical layer—the foundational hardware of telecommunications networks—up to the application level." He continued, "Advanced wireless systems and protocols are increasingly critical to the national economy and resilience and resistance to attack are key to protecting vital investments already made and that are continuing to be made."

The project from the Center for Cybersecurity focuses on building next-generation resilient wireless systems from unsecure hardware. The researchers are looking into ways of flagging so-called hardware Trojans. These are malicious additions to hardware components supplied by a third party in order to launch an attack from within a network node, such as a cellular base station. Once triggered, these attacks can degrade or disable service, transmit signals to disrupt other nodes, or snoop or leak sensitive data.

Among the research team's objectives are estimating the capacity of undetected hardware attacks and optimizing the power and computation devoted to hardware verification. They will apply these methods to networks, making it easier to detect jamming and multi-user attacks. The researchers are also developing a novel and powerful evaluation platform to experiment with hardware security methods at different regions of the radio spectrum.

According to Ramesh, Co-Chair of NYU Center for Cybersecurity, his project will explore attackers' and defenders' use of analog side channels unique to 5G, including radio frequencies in the millimeter-wave spectrum, side-by-side computer system timing information, power consumption, and digital side channels. The defenses will be evaluated on a 5G software-defined radio through the use of crowdsourcing as part of NYU Tandon's 2022 CSAW Embedded Security Challenge.

"There is growing interest in the resilience and security of 5G," added Shiv. "NYU Tandon, home to the Center for Cybersecurity, CATT, and NYU WIRELESS, is in a great position to work at this intersection of security and wireless

to secure the current and next generation of telecommunications."

Another project aims to advance data modeling with the goal of enabling resilient edge networks with data-driven model-based learning. Computational wireless systems enable secure, robust, and high-performance applications in education, business, transportation, healthcare, entertainment, and more. Edge networks, where computation and data storage capabilities are as close as possible to the source of a request, are key to their success.

Of the RINGS partnership grants awarded to 37 institutions, NYU Tandon was one of only three to receive a trio of them.

The investigators will address vulnerabilities that could affect the availability, reliability, and resiliency of edge networks. These include both expected resource and demand variations (such as diurnal application traffic patterns, user mobility, and random link/node failures), unexpected shifts of operating conditions (such as traffic flash-crowds triggered by emerging events), and major infrastructure failures after coordinated malicious attacks and natural disasters.

Together with Andreas Molisch of the University of Southern California, Elza is the co-principal investigator on a project to enable resilient delivery of real-time interactive services over NextG computer-dense mobile networks. Their research takes a hard look at real-time interactive services (RTIs), a technology at the intersection of sensing, computation, and communications. Traditionally, these systems are not optimized to work with each other, particularly not in real-time, constraining the type of services that they can enable.

RTIs require real-time aggregation of distributed data streams onto edge/cloud computer servers that can process data as soon as it is generated. To make this possible, the investigators will develop a mathematical framework and algorithms to provide such RTIs with guaranteed latencies.

"The results will benefit the U.S. economy by enabling more efficient, more reliable, and more resilient automation schemes—for example for smart factories and farms—as well as improved augmented/virtual reality," said Elza.

As part of the projects, the teams will engage local citizen scientists to create educational opportunities around the research and will disseminate the results and data to the wider community through workshops. In addition, the principal investigators teach security and wireless classes at NYU and will integrate the research and experiments into their classes and class projects.

"Our project will include a robust plan for outreach to students from underrepresented groups," Elza added. "The interdisciplinary nature of the research will benefit participating students." Congratulations to all the grant recipients!

SAVE THE DATES

Brooklyn 6G Summit
In-person event: October 24–27, 2022
For more information, visit B6GS.com

NYU WIRELESS Board Meeting
In-person event: October 24, 2022

NYU WIRELESS Workshop: Re-Inventing the Physical Layer
Invitation only; October 27–28, 2022

Faculty News

Elza Erkip
Institute Professor, ECE

Thomas L. Marzetta
Director, NYU WIRELESS

Henry Bertoni
Professor Emeritus, ECE

Farokh Atashzar
Assistant Professor, ECE

Theodore Rappaport
Founding Director,
NYU WIRELESS

Elza Erkip Receives Armstrong Award

Professor Elza Erkip was honored by the IEEE Communications Society, which on December 8, 2021, presented her with the prestigious Edwin Howard Armstrong Achievement Award in recognition of her pioneering work in cooperative communications and relay networks. She is only the third woman to receive this distinction. Users of smart phones and IoT devices may not be aware of the kinds of advances made possible by Elza's groundbreaking research in information theory, but cooperative networking, for example, greatly increases the reliability and speed of wireless networks, resulting in faster downloads and better coverage. Her revolutionary work thus helped lay the foundation for the 5G service now being widely commercialized, as well as the possibilities for 6G currently being explored.

Highly Cited Researchers

NYU WIRELESS Director Tom Marzetta and Founding Director Ted Rappaport were joined by Professor Elza Erkip on Clarivate's 2021 list of Highly Cited Researchers. Individuals who have received this honor have published multiple papers over the past decade that consistently rank in the top one percent by citations in their field. Experts from the Institute for Scientific Information at the Web of Science Group, which is part of Clarivate Analytics, determine who is included in this influential group.

Ted Rappaport Named Innovator of the Year

NYU WIRELESS Founding Director Ted Rappaport was honored by the Tesla Science Center as its 2021 Innovator of the Year. The Center noted that Ted "embodies the spirit of Nikola Tesla's legacy of advancing technology for humanity."

The award was presented on November 19, 2021, during a virtual gala, "World Gone Wireless," which featured animated video together with taped footage of guests. Among those who offered tributes was Vincent Cerf, known as a "Father of the Internet," who was a previous recipient of the award. He praised Ted for being "way ahead of his time." A number of Ted's colleagues, mentors, students, and friends provided moving video tributes that acknowledged his many contributions to the field.

In addition, Ted was ranked No. 15 among U.S. scientists in electronics and electrical engineering and No. 27 globally, according to the website Research.com, which evaluates authors based on their H-index. This index uses the number of published papers and citations to determine a scientist's ranking.

EurAAP Propagation Award

Professor Emeritus Henry Bertoni was awarded the EurAAP Propagation Award in March 2022 by the European Conference on Antennas & Propagation. He received the award for the development of propagation prediction models used for the design of cellular networks.

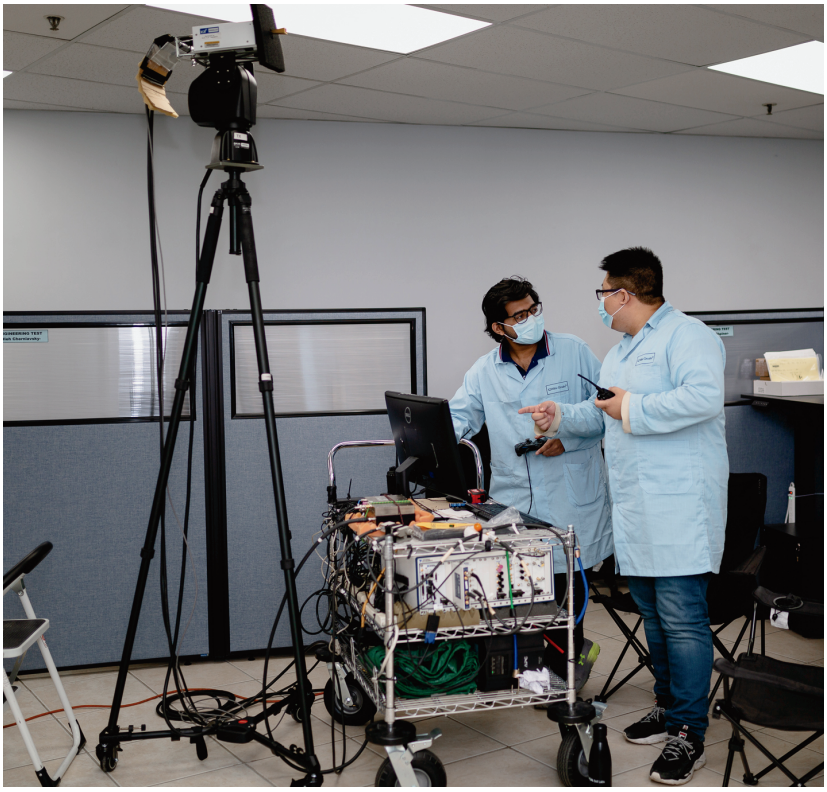
NSF Award to Help Stop Pandemics

Assistant Professor Farokh Atashzar received a National Science Foundation award to develop novel computational network modeling to help mitigate the spread of pandemics such as COVID-19. He will be conducting his research together with colleagues at Northeastern University. His grant is titled "Modeling and Control of Non-Passive Networks with Distributed Time-Delays: Application in Epidemic Control."

Mini-Circuits Hosts Pioneering 6G Researchers

Deployment of 5G commercial wireless networks is well underway. Mini-Circuits, a New York–based RF and microwave technology leader, supplies a wide range of components to 5G hardware developers for testing and system use, but the real buzz on the floor of the company's Brooklyn lab has already moved on to 6G.

On January 10, 2022, Mini-Circuits welcomed graduate researchers from NYU WIRELESS to its facilities as part of its efforts to pave the way for the next great revolution in wireless communications. Still about a decade away from deployment, much about 6G wireless technologies remains to be defined, but at a high level 6G will build on previous technologies to allow even greater bandwidth, lower latency, and more unprecedented applications than is possible with 5G networks. Ultimately, 6G will enable the "unification of our experience across the physical, digital, and human world," according to Harish Viswanathan, NYU WIRELESS Industrial Affiliate Nokia Bell Labs Head of Radio Systems Research.



Researchers from NYU WIRELESS set up equipment to gather measurements of Sub-THz signals. Shown (l. to r.) are Hitesh Poddar and Yunchou Xing.

Shihao Ju, a third-year Ph.D. student at NYU WIRELESS, is one of five researchers from Professor Ted Rappaport's student group collecting radio propagation measurement data at Mini-Circuits' Neptune Avenue test labs in Brooklyn and in its warehouse facility in Deer Park, Long Island. He and his fellow Ph.D. candidates Yunchou Xing (recently graduated and now with Nokia Bell Labs), Ojas Kanhere, Dipankar Shakya, and Hitesh Poddar comprise a research team dedicated to measuring and modelling the propagation characteristics of ultra-wideband signals at 142 GHz.

"We're trying to develop the first general spatial statistical channel model for frequencies above 100 GHz for various environments," said Shihao. "Before this, we were doing measurements in office buildings and outdoor urban street canyons. Now we're doing it for industrial scenarios for future 6G-enabled smart factories."

Channel models allow the engineers designing the wireless infrastructure to accurately simulate how signals behave in real-world environments, from inside buildings to urban streets, and even thinly settled rural expanses. Wireless standardization bodies such as 3GPP and IEEE 802.11 must agree on a single accepted channel model before companies can submit proposals for commercial development. The researchers'

work will be foundational to the standards that eventually come together as 6G evolves from concept to reality.

Capturing signal propagation behaviors and channel statistics in real-world factory and warehouse spaces is particularly important to opening up the cloud computing and automation capabilities needed to realize smart factories and industry 4.0. Manufacturing environments are often crowded with physical obstructions and electromagnetic interference from other machinery, which makes understanding signal behavior anything but straightforward.

"Signals propagating in any environment will get reflected, scattered, or penetrate walls," explained Shihao. "That's going to create multipath components more than a mere line-of-sight, single path. Here, we can derive a faithful channel model based on the measured multipath data to provide a more realistic analysis of all different wireless system design problems."

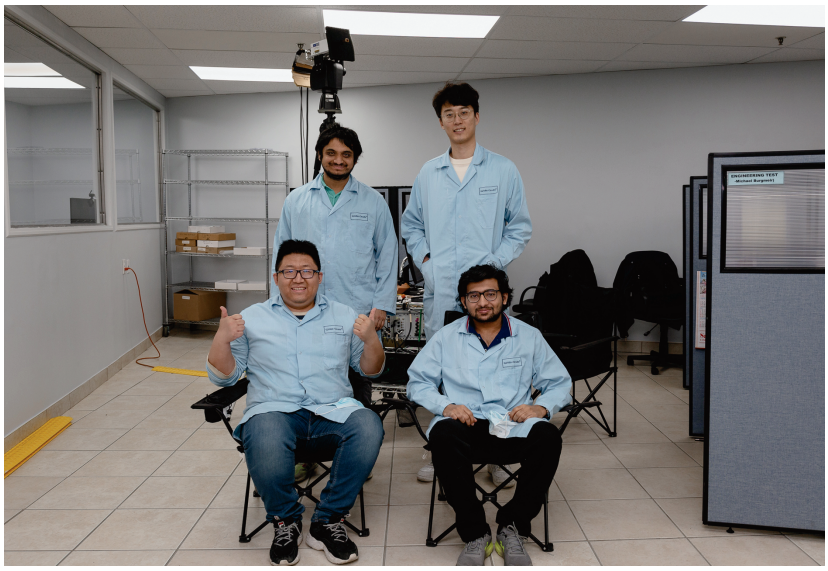
Mini-Circuits President, Ted Heil, first learned of the work the research team was doing at the Brooklyn 6G Summit, which is hosted annually by Nokia and NYU WIRELESS at the Tandon campus. He approached Professor Ted Rappaport and offered to make Mini-Circuits' facilities available as a test bed for his team. As one of the few companies maintaining industrial-scale manufacturing operations in the NYC area, it was a unique opportunity to collect much-needed data close to home.

> "We're trying to develop the first general spatial statistical channel model for frequencies above 100 GHz for various environments."

The channel model that comes out of this effort will be the first of its kind. Shihao explained that models of this scope have been developed for lower frequencies, but at the frontiers of the Sub-THz spectral region, most measurements previously collected were done at low power over distances of only a few meters. The NYU team's model will incorporate measurements at large scale up to 50 meters in the full range of environments that encompass real-world operating conditions.

Mini-Circuits has long been dedicated to fostering collaboration between academia and the RF/microwave industry, but this may be the first time one such collaboration will be instrumental to active research shaping the future of wireless communications. As you start to hear more about how 5G and 6G are powering smart factories and transforming industry as we know it, think about how this small team of NYU WIRELESS researchers and a global technology company in Brooklyn helped pioneer the research that made it all possible.

Article adapted and reprinted courtesy of Mini-Circuits.



Top: The channel sounder used in the measurement experiments.

Bottom: The NYU research team of Professor Rappaport at Mini-Circuits' Neptune Avenue facility in Brooklyn. Shown standing (l. to r.) are Ojas Kanhere and Shihao Ju; sitting (l. to r.) are Yunchou Xing and Hitesh Poddar.

The Doctor is Almost In

NYU Tandon's Medical Robotics and Interactive Intelligent Technologies lab (MERIIT), which conducts research on human-centered robotics, human-machine interface, and human-AI collaboration, recently received a major equipment donation from the Intuitive Foundation: a da Vinci Research Kit (dVRK).

The kit, an open-sourced version of the classic da Vinci Surgical System manufactured by Intuitive Surgical Inc., comprises the surgeon's side robotic console with two robotic arms and a 3D video display; a stereo-vision camera system and surgical endoscope; and a two-arm patient's side robotic console. As of August, the dVRK was in the process of being installed.

The da Vinci Surgical System is a leader-follower teleoperated robotic system that is operated on local networks, with the surgeon positioned feet away from the patient, in the same (or an adjacent) room. Advances in telecommunications from 5G and 6G and beyond offer the tantalizing prospect that procedures could one day be performed by a surgeon who is miles away from the operating theater, or even in another part of the world.

The Intuitive Foundation's donation will allow MERIIT to implement, mobilize, and evaluate outcomes, algorithms, and intelligent architectures in the area of telerobotic surgery, helping to democratize access to the technology and skilled practice.

The MERIIT lab, led by NYU WIRELESS Assistant Professor Farokh Atashzar, aims not only to remove the barrier of distance between skilled surgeons and patients, but to develop haptic interfaces that will enable the surgeon, however far away he or she may be from the operating theater, to physically perceive the smallest forces applied on the tissue during a remote and delicate operation. MERIIT's work is just one example of the state-of-the-art robotic research being conducted at NYU Tandon.

Farokh explained that remote telesurgery is closer to reality than many people may think, given the emergence of wireless networks with ultra-low latency and ultra-high reliability. "This technology could create more access to surgical specialists," Farokh said. "The best surgeon for a given procedure, who happens to be in California, could conceivably operate on a patient in New York. That means areas with limited access to healthcare could have access to specialized surgical procedures, and it also creates options for treatment in dangerous areas, battlefields, or even in space, if the surgeon is Earthbound."

Additionally, he pointed out, multimodal telerobotics can also be used to physically separate surgeons and patients during a critical health crisis such as a pandemic like COVID-19, in order to minimize the possibility of infection transmission.

NYU WIRELESS Assistant Professor Farokh Atashzar holds a high definition stereo camera that provides 3D depth perception at the surgeon's console (behind him) and a "six degrees of freedom" surgical tool that is inserted into the patient in the operating room.

The MERIIT lab's research using the donated system has three major pillars:

- MERIIT researchers will conduct cutting-edge research on surgical autonomy and shared autonomy, using the parts of the operation that can be shared between local machines and remote surgeons. This will be achieved using advanced robot learning algorithms and artificial intelligence being developed at MERIIT.
- Researchers will develop novel fundamental algorithms that maximize the transparency, perception, and stability of telerobotic surgical systems, in the presence of communication latency, jitter, and packet loss. The team will develop nonlinear controllers to stabilize the networked leader-follower robotic systems. They will also generate artificial intelligence that can compensate for the effect of degradations in QoS through adaptive computational modeling.
- Researchers will develop multi-agent networked robotic systems to enable virtualized hand-over-hand training for novice surgeons under the guidance of an expert through shared virtual reality and telecommunication between multiple robots.

Farokh said the goal of autonomous surgical systems is to improve the performance of remote human operators, at least initially. "We want to keep the surgeon in the loop, but with the goal of enabling different levels of shared autonomy between human and machine intelligence," he explained.

One of the challenges of remote telesurgey that Farokh is most interested in tackling is "taking the next fundamental steps in telerobotic surgery by enabling 'Remote Tactile Intelligence.' This would require a combination of remote tactile rendering, remote sensing, tactile internet, and cloud computing for partially automated surgeries and reducing the current sensitivity to QoS (quality of service)." Farokh further noted, "Telerobotics has augmented the 'manipulability' and 'maneuverability' competence of surgeons. However, commercial examples of surgical robots block surgeons from 'feeling' their way with haptics. Despite the existing evidence on the significance of haptics in surgery, commercial systems are yet to deliver haptics due to several technical challenges."

This researcher is using a state-of-the-art 64-channel electroencephalographic (EEG) machine to scan brain activities in real time and transmit the data wirelessly to a computer controlling the robot.

Technical challenges include ensuring perceptual causality, safety, reliability, stability, and rendering fidelity (i.e., transparency), which are all susceptible to inevitable network latency and in general discrepancy in the quality of network service. Meanwhile, networked robotic systems could make possible such pedagogical scenarios as surgical training in which an experienced surgeon uses such systems to simultaneously teach multiple students who are physically in different locations. Conceivably, novice surgeons could "all be working under the guidance of one expert surgeon performing a virtually/physically simulated surgery, from any location," Farokh said.

Advances in telecommunications from 5G and 6G and beyond offer the tantalizing prospect that procedures could one day be performed by a surgeon who is miles away from the operating theater, or even in another part of the world.

Industrial Affiliate Events: One Key to a Great Relationship

Our Industrial Affiliates are among NYU WIRELESS' greatest assets. We rely on the feedback of these supportive companies to help shape our programs, and we pride ourselves on providing them with valuable information that advances the industry. Our events this year have been planned with these goals in mind.

Open House

Our 2022 Virtual Open House in January included more than 35 Industrial Affiliates and a comparable number of NYU WIRELESS faculty members and students. As in past years, the Open House facilitated connections between students seeking internships or full-time positions and Industrial Affiliates recruiting highly qualified individuals for roles at their companies. To familiarize Industrial Affiliates with the skills and projects of our students, each student prepared a one-minute video explaining his or her research. The students later made themselves available to discuss their work in greater detail with interested Industrial Affiliates.

Among the impressive work presented was a poster by Ozlem Yildiz and Abbas Khalili, who are supervised by Professor Elza Erkip. Their research focused on noiseless interactive hybrid beam alignment in an uplink single user scenario, where the channel between the user and the base station consisted of multiple paths. The team's future work will include addressing optimized beam alignment methods for noisy systems.

Another project—presented by Lifan Mei, Jinrui Gou, Yujin Cai, and Houwei Cao, students of Professor Yong Liu—studied the effects of realtime mobile bandwidth and handoff predictions in 4G/5G networks. They explained that for bandwidth-demanding apps such as video conferencing, accurate bandwidth prediction can lead to better quality of experience for users. In co-existing 4G and 5G networks, the group proposed a solution for predicting handoffs between 4G and 5G, which is important for high-bandwidth and low-latency applications in these co-existing networks.

NYU WIRELESS researchers testing an advanced wearable device for visually impaired pedestrians (l. to r.): Postdoctoral Associate Alain Boldini, Professor Yao Wang, and Professor J.R. Rizzo.

Board Meeting

Our virtual NYU WIRELESS board meeting brought our Industrial Affiliates and faculty members together to share research news and other updates. Held on April 26, 2022, the half-day session provided an important touchpoint for the Affiliates and NYU WIRELESS to stay

connected. We also rely on our Affiliates for input regarding current and future research directions and areas on which they would like to focus.

We invite our Industrial Affiliates to access this information and more at the Affiliate portal on NYUWIRELESS.com.

NYU WIRELESS Workshop

Among the highlights of 2021 for NYU WIRELESS was the inaugural NYU WIRELESS Workshop, held virtually on October 28, 2021. The intent of this workshop is to bring the foremost wireless researchers together for a free exchange of ideas. A limited-attendance invitation-only event, the workshop was focused on a specific research theme, "Re-Inventing the Physical Layer." The first workshop was organized by Tom Marzetta and Elza Erkip of NYU WIRELESS, Liesbet Van der Perre of KU Leuven, Belgium, and Petar Popovski of Aalborg University, Denmark. The half-day event consisted of two provocative panels, "Are Ever Higher Carrier Frequencies a Safe Bet?" and "Who Will Create the Next Wireless Generations: Turning, or Maxwell and Shannon?"

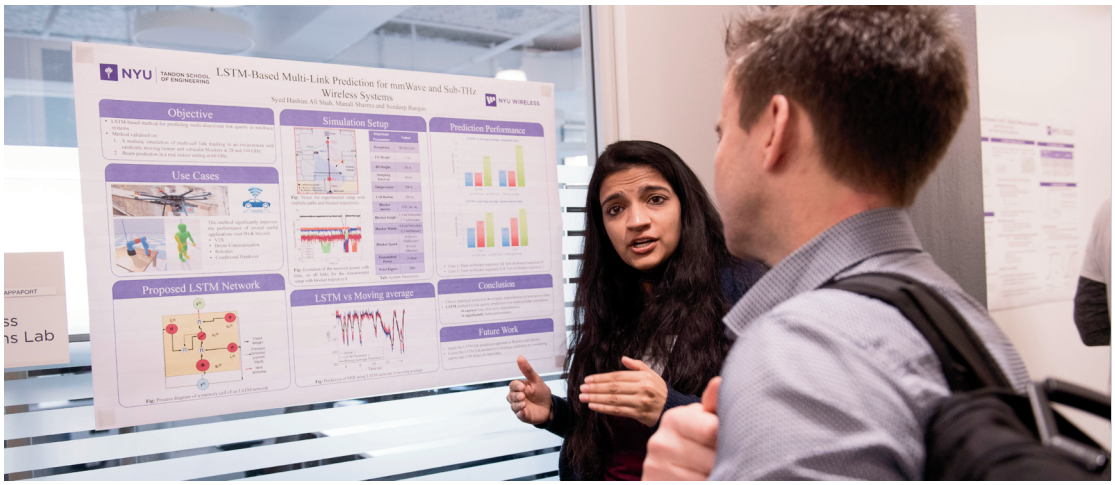
The second annual workshop will be a live event in Brooklyn on October 27–28, 2022, with the same theme as the first workshop, but with additional time for panels, keynotes, posters, and informal discussion. As a new membership benefit, NYU WIRELESS Industrial Affiliates are each invited to select two participants.

Brooklyn 6G Summit

"Path Towards a Sustainable 6G World" was the theme of this year's Brooklyn 6G Summit, which offered insights into how a 6G system can be designed from the onset with sustainability in mind. Presented on April 27, 2022, by NYU WIRELESS and Nokia, the virtual conference featured a keynote talk by Kimberley Parsons Trommler, head of Thinknet 6G at Bayern Innovativ. She discussed the United Nations' sustainable development goals for 6G, digital responsibility goals, and commitments from the wireless industry to develop a sustainable 6G network. Other speakers included John Smee from Qualcomm, who explained how the next generation of device capabilities will drive the needs-identification of how to scale sustainability. Balazs Bertenyi, Principal Standardization Architect at Nokia, kicked off the main discussion by considering the climate impact of mobile technology in an increasingly complex world. In addition to other notable speakers, Professor Ted Rappaport from NYU WIRELESS discussed "Power Consumption and Efficiency in mmWave and Sub-THz Systems and Networks." Among Summit highlights was Ted's Fireside Chat with former FCC Chairman Tom Wheeler, who received the Pioneer Award for his impactful work in the telecommunications industry over the past four decades.

A recording of the Summit can be accessed at ieeetv.ieee.org/event/2022-brooklyn-6g-summit.

Diversity and Inclusion for Women at NYU Tandon School of Engineering



Tandon's Class of 2022 is

43% women,

roughly double the national average for engineering schools.

NYU WIRELESS, like the entirety of NYU Tandon School of Engineering, prides itself on an inclusive culture, regarding it as the guiding principle in its policies and day-to-day interactions. From student admissions to faculty recruitment to speaker engagements, we firmly believe that gender and cultural diversity enhance scientific creativity and productivity. To this end, Tandon School of Engineering has increased its efforts to support its women students in multiple and meaningful ways. This is exemplified by the introduction of a minor in Feminism and Science, Technology, Engineering, and Math (FSTEM), a plan to open a Women in STEM Center at Tandon, and Dean Jelena Kovačević's commitment to building and nurturing a diverse and inclusive community.

Seven years ago, the Women @ Tandon committee (W@T) was founded to help address the issue of gender inequality. In the ensuing years, W@T has thrived, establishing an Alumnae Advisory Council Student Engagement Scholarship Fund. Programming includes lunchtime talks and Empower Hours, as well as the formation of We for She, a group for male allies. In addition, the Inclusion @ Tandon committee and the Office of Inclusive Excellence were created. There are also a number of clubs for female students to find peer support, including Girls Who Code, Society of Women Engineers, STEMinist, and Women in Business and Entrepreneurship.

Every year NYU Tandon hosts a Women in STEM summit, and in 2020 NYU Tandon's Department of Computer Science and Engineering received a National Center for Women and Information Technology Extension Services (NEXT) Award for its efforts to double the number of women in computer science, a goal they far exceeded. This success was not limited only to the CSE department: The Tandon Class of 2022 is made up of 43% women—roughly double the national average for engineering schools.

More generally, kudos to NYU Tandon for rising to Number 33 in the ranking of graduate engineering schools compiled by *U.S. News & World Report*. This achievement, which reflects the surpassing of forty-seven schools over the last fifteen years, can be attributed to the quality of our faculty and student research, the caliber of our public and private-sector collaborations, innovative multi-disciplinary teams, and increased community engagement.

Goodbye 3G

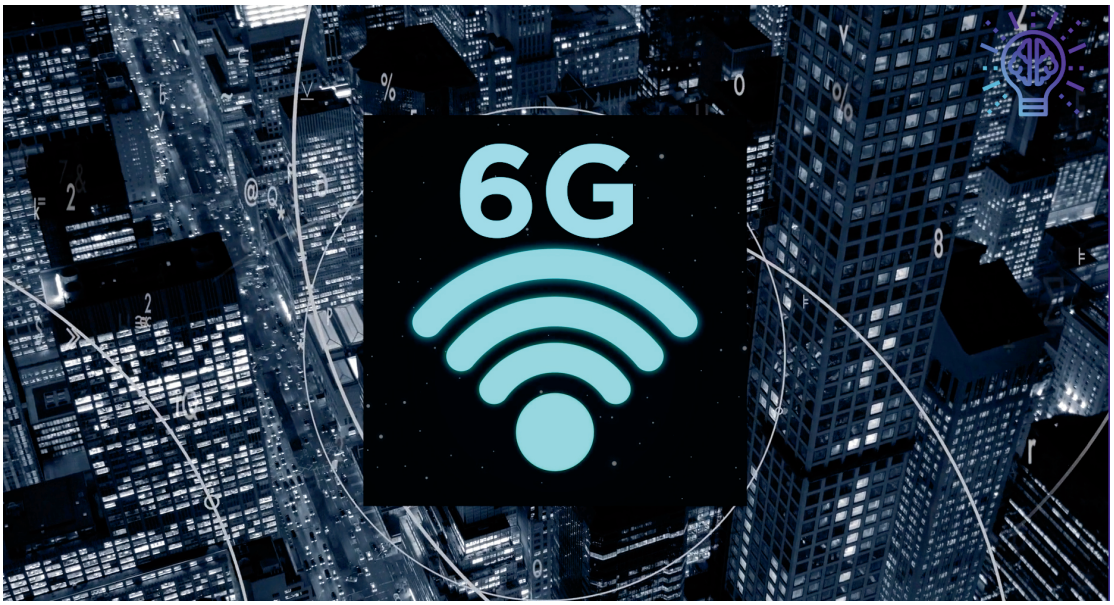
In the early months of 2022, major wireless carriers began phasing out 3G wireless networks across the United States in order to make room for 4G and 5G networks. This is not the first time a network has been sunsetted: Most 2G networks were shut down by 2017.

Companies are moving away from 3G after a relatively short time (only eighteen years vs. 2G's approximately thirty years) because bandwidth is valuable, and it's crucial to free up as much as possible to accommodate future 5G deployment. Any frequencies that can be cleared by sunsetting 3G can be directed toward those needs.

There has been some concern about the retirement of 3G, as there are still people using older cell phones that run on 3G, and many cars rely on 3G networks for navigation and location data, emergency calls, remote lock functions, and more. However, Professor Sundeep Rangan, Associate Director of NYU WIRELESS, is not concerned. When interviewed about the upcoming changes by news outlets *IEEE Spectrum* and *Vox*, he explained that while 3G is going away, it won't disappear overnight. Sunsetting a wireless network takes time, he said, as it requires going site by site to each cell tower to shut off the relevant equipment.

"Operators are spending a lot of money for the spectrum," Sundeep explained in an article in *Vox*. "Those operators, for that amount of spectrum, want to send as much data, or serve as many users, as possible."

Brainiacs Explain 6G

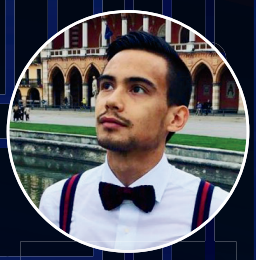


NYU's inventive Brainiacs recently produced an episode that focuses on 6G research underway at NYU WIRELESS. Now available for viewing on YouTube, the short video—which features NYU WIRELESS professors Sundeep Rangan, JR Rizzo, and Ludovic Righetti together with Brainiacs visual storyteller Sapna Parikh—describes a few of the many exciting advances we can look forward to in the next decade. The professors explain how 6G's faster data transfers with less delay will translate into real-world applications such as devices to help the visually impaired navigate in real time, richer virtual reality experiences, improvements to AI and robot technology, aid for individuals impacted by natural disasters, and more. Be sure to check out "Braniacs Episode 7: What is 6G Wireless?" on YouTube to learn more.

Summer Internships

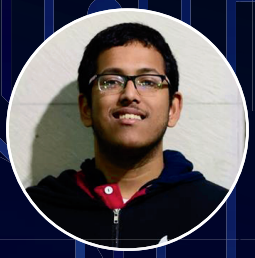
NYU WIRELESS would like to thank our Industrial Affiliate Members for providing valuable workplace experience again this year through summer internships, as well as full-time career opportunities to our graduates. Each January, our Open House/Recruiting Day provides an occasion for our students to connect with top industry leaders and potential employers to learn more about the companies and available employment opportunities. Attracting top talent for internships and full-time positions at the annual Open House/Recruiting Day is just one of the many benefits of becoming an NYU WIRELESS Industrial Affiliate.

Congratulations to our graduating students and those students who had summer internships this year!



Tommy Azzino
Qualcomm
New Jersey

Fabrizio Carpi
Nokia Bell Labs
Murray Hill, NJ



Soumyadeep Datta
XCOM Labs
San Diego, CA

Ruth Gebremedhin
Nokia Bell Labs
Remote

Nikola Janjusevic
Apple
Cupertino, CA

Chen Li
Amazon
San Diego, CA

Mustafa Ozkoc
Samsung Research Lab
Plano, TX

Hitesh Poddar
Sharp Labs
Vancouver, WA

Jyotish Robin
Samsung Research Lab
Plano, TX

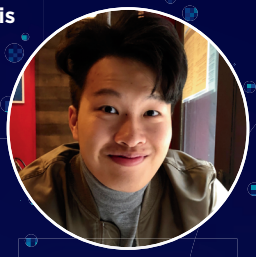
Syed Hashim Ali Shah
Qualcomm
San Diego, CA

Dipankar Shakya
Nokia Bell Labs
Murray Hill, NJ

Panagiotis Skrimponis
Samsung
Semiconductor US
San Jose, CA

Ashutosh Srivastava
Meta (Facebook)
Redmond, WA

Ozlem Yildiz
Dell
Remote



Mingsheng Yin
Nokia Bell Labs
Murray Hill, NJ

Graduating Ph.D. Students

Zhipeng Fan

Shihao Ju
MediaTek

Ojas Kanhere
AT&T

Amir Khalilian
NYU Langone Comprehensive Epilepsy Center

Thanos Koutsaftis

Lifan Mei
AWS

Abbas Khalili Olam

Ziming Qiu

Syed Hashim Shah
Qualcomm

Calgar Tunc
AT&T Labs

Yunchou Xing
Nokia Bell Labs

Benjamin Ades-Aron
Yujin Cai
Yixiang Mao, Apple
Ran Wang

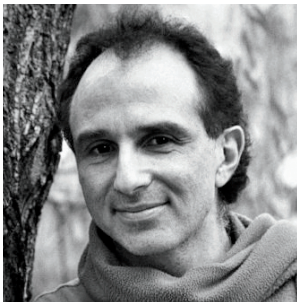
NYU WIRELESS Faculty, Post-Docs, and Research Engineers

Theodore Rappaport
Founding Director & David Lee/Ernst Weber Professor, ECE, CS, Medicine

Thomas L. Marzetta
Director & Distinguished Industry Professor, ECE

Sundeep Rangan
Associate Director & Professor, ECE

John-Ross Rizzo
Associate Director & Professor, NYU Langone Health



Dennis Shasha
Associate Director & Professor, CS

Sundar Aditya
Post-Doctoral Associate

Farokh Atashzar
Assistant Professor

Henry Bertoni
Professor Emeritus, ECE

Marwa Chafii
Associate Professor, ECE

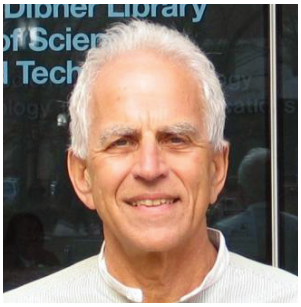
Aditya Dhananjay
Post-Doctoral Associate, ECE

Elza Erkip
Institute Professor, ECE

Fraida Fund
Post-Doctoral Associate

Follow NYU WIRELESS on **Twitter**
@NYUWIRELESS

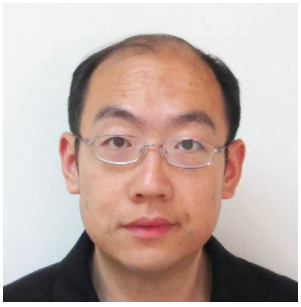
Siddharth Garg
Associate Professor, ECE



David Goodman
Professor Emeritus, ECE

Ramesh Karri
Professor, ECE

Michael Knox
Industry Professor, ECE



Pei Liu
Research Scientist, ECE

Yong Liu
Associate Professor, ECE

Giuseppe Loianno
Assistant Professor

Marco Mezzavilla
Research Scientist, ECE

Shivendra Panwar
Professor, ECE

Davood Shahrjerdi
Associate Professor, ECE

Farhad Shirani
Research Assistant Professor, ECE

Lakshminarayanan Subramanian
Associate Professor, CS

Yao Wang
Professor, ECE & BioMed

Welcome Marwa!

NYU WIRELESS is pleased to welcome Associate Professor Marwa Chafii, who is based in the Engineering Division in NYU Abu Dhabi. Marwa's areas of interest include advanced waveform design, machine learning for wireless communications, and indoor localization. Marwa is already becoming a vital part of NYU WIRELESS and is opening up the center to the Middle East and Asia in her first year on the NYU faculty.

Marwa received her Ph.D. in electrical engineering in 2016 and her Master's degree in the field of advanced wireless communication systems in 2013, both from CentraleSupélec (France). Between 2014 and 2016, she was a visiting researcher at Poznan University of Technology (Poland), University of York (UK), Yokohama National University (Japan), and University of Oxford (UK). In 2018 she joined the Technical University of Dresden (Germany) as a research group leader in the Vodafone Chair for Mobile Communications Systems group of Professor Gerhard Fettweis. In 2019 she became an associate professor at ENSEA (France), where she held a Chair of Excellence on Artificial Intelligence from the CY Initiative. Since September 2021, she has been an associate professor at both NYU Abu Dhabi and NYU WIRELESS at NYU Tandon School of Engineering.

She received the prize for the best Ph.D. in France in the fields of Signal, Image & Vision, and in 2020 she was recognized by N2Women as one of the "Top 10 Rising Stars in Computer Networking and Communications." Marwa served as associate editor of IEEE Communications Letters in 2019–21, where she received the Best Editor Award in 2020. Between 2018 and 2021, she was research lead at the Women in AI organization. She is currently Associate Editor at IEEE Transactions on Communications, serving as vice-chair of the IEEE ComSoc ETI on Machine Learning for Communications and leading the Education working group of the IEEE ComSoc ETI on Integrated Sensing and Communications.

"I am extremely excited to join NYU WIRELESS and work with academic and industrial leaders to develop cutting-edge research on the next generations of wireless communication systems."

Marwa recently discussed her current role: "I am extremely excited to join NYU WIRELESS and work with academic and industrial leaders to develop cutting-edge research on the next generations of wireless communication systems. Through my role in NYU Abu Dhabi, we are working closely with NYU WIRELESS on starting a wireless research center in Abu Dhabi, leveraging the synergy between both campuses to make a strong impact in the telecommunications sector locally and globally. As the first faculty member in wireless joining NYUAD, I am very eager to be part of this unique adventure." As she explained further, "I have already started building my new research group, and five talented researchers have already joined me. We are working together with NYU WIRELESS faculty and students, supported by our Industrial Affiliates, toward the development and deployment of the next generations of wireless systems."

Please join us in welcoming Marwa to NYU WIRELESS.

NYU WIRELESS Recent Publications

June 2021–June 2022

5G & 6G Applications

J. Viereck, A. Meduri, L. Righetti, "ValueNetQP: Learned one-step optimal control for legged locomotion," in Proceedings of Machine Learning Research, 2022, vol. 144, 1–12.

B. Hammoud, A. Jordana, L. Righetti, "iRiSC: Iterative Risk Sensitive Control for Nonlinear Systems with Imperfect Observations," in American Control Conference, 2022

D. Shakya, D. Chizhik, J. Du, R. A. Valenzuela, T. S. Rappaport, "Dense Urban Outdoor-Indoor Coverage from 3.5 to 28 GHz," in ICC/IEEE International Conference on Communications, May 2022, pp. 1–6

M. Yin et al., "Millimeter Wave Wireless Assisted Robot Navigation with Link State Classification," in IEEE Open Journal of the Communications Society, March 2022, vol. 3, pp. 493–507, doi: 10.1109/OJCOMS.2022.3155572

L. Sun, Y. Mao, T. Zong, Y. Liu, Y. Wang, "Live 360 Degree Video Delivery based on User Collaboration in a Streaming Flock," in IEEE Transactions on Multimedia, Feb. 2022, doi: 10.1109/TMM.2022.3149642

B. Hammoud, L. Oliveri, L. Righetti, J. Carpentier, A. Del Prete, "Exponential Integration for Efficient and Accurate Multi-Body Simulation with Stiff Viscoelastic Contacts," in Multibody System Dynamics, 2022

C. Slezak, S. Rangan, "Measurement-Based Indoor Millimeter Wave Blockage Models," in IEEE Transactions on Wireless Communications, Feb. 2022, doi: 10.1109/TWC.2022.3152428

A. Devo, J. Mao, G. Costante, G. Loianno, "Autonomous Single-Image Drone Exploration with Deep Reinforcement Learning and Mixed Reality," in IEEE Robotics and Automation Letters, April 2022, vol. 7, no. 2, pp. 5031–5038, doi: 10.1109/LRA.2022.3154019

C. Cho, M. A. Maloy, S. M. Devlin et al., "Ionizing radiation exposure after allogeneic hematopoietic cell transplantation," in Bone Marrow Transplant, Feb. 2022, doi: 10.1038/s41409-022-01612-x

G. Li, A. Tunchez, G. Loianno, "Learning Model Predictive Control for Quadrotors," in arXiv preprint arXiv:2202.07716, Feb. 2022, doi: 10.48550/arXiv.2202.07716

S. T. Bui, Q. K. Luu, D. Q. Nguyen, N. D. M. Le, G. Loianno, V. A. Ho, "Tombo Propeller: Bio-Inspired Deformable Structure toward Collision-Accommodated Control for Drones," in arXiv preprint arXiv:2202.07177, Feb. 2022, doi: 10.48550/arXiv.2202.07177

A. Khalili, E. Erkip, S. Rangan, "Quantized MIMO: Channel Capacity and Spectrospatial Power Distribution," in arXiv preprint arXiv:2202.02934, Feb. 2022, doi: 10.48550/arXiv.2202.02934

T. Sun, J. Libby, J. R. Rizzo, S. F. Atashzar, "Deep Augmentation for Electrode Shift Compensation in Transient-phase High-density Electromyographical Neural Interfaces: Towards Application in Neurorobotics," in bioRxiv 2022.02.25.481922, doi: 10.1101/2022.02.25.481922

Y. Zhou, J. Xiao, G. Loianno, "Multi-Robot Collaborative Perception with Graph Neural Networks," in IEEE Robotics and Automation Letters, April 2022, vol. 7, no. 2, pp. 2289–2296, doi: 10.1109/LRA.2022.3141661

L. Mei, J. Gou, Y. Cai, H. Cao, Y. Liu, "Realtime mobile bandwidth and handoff predictions in 4G/5G networks," in Computer Networks, 2022, doi: 10.1016/j.comnet.2021.108736

M. H. Yeganegi, M. Khadiv, A. D. Prete, S. A. A. Moosavian, L. Righetti, "Robust Walking Based on MPC with Viability Guarantees," in Nov. 2021, IEEE Transactions on Robotics, doi: 10.1109/TRO.2021.3127388

S. H. A. Shah, S. Rangan, "Multi-cell Multi-beam Prediction Using Auto-encoder LSTM for mmWave Systems," in TechRxiv, Dec. 2021, doi: 10.36227/techrxiv.17695394.v1

R. Vunikili, B. S. Glicksberg, K. W. Johnson, J. T. Dudley, L. Subramanian, K. Shameer, "Predictive Modelling of Susceptibility to Substance Abuse, Mortality and Drug-Drug Interactions in Opioid Patients," in Frontiers in Artificial Intelligence, Dec. 2021, vol. 4, doi: 10.3389/frai.2021.742723

S. Kang et al., "Millimeter-Wave UAV Coverage in Urban Environments," in IEEE Global Communications Conference, 2021, pp. 1–6, doi: 10.1109/GLOBECOM46510.2021.9685535

M. G. Boroujeni, E. Daneshman, L. Righetti, M. Khadiv, "A unified framework for walking and running of bipedal robots," in 20th International Conference on Advanced Robotics, 2021, pp. 396–403, doi: 10.1109/ICAR53236.2021.9659392

A. A. Farid, A. S. H. Ahmed, A. Dhananjay, P. Skrimponis, S. Rangan, M. Rodwell, "135GHz CMOS / LTCC MIMO Receiver Array Tile Modules," in IEEE BiCMOS and Compound Semiconductor Integrated Circuits and Technology Symposium, 2021, pp. 1–4, doi: 10.1109/BCICTS50416.2021.9682493

A. Balashankar, L. Subramanian, S. P. Fraiberger, "Fine-grained prediction of food insecurity using news streams," in arXiv preprint arXiv:2111.15602, Nov. 2021, doi: 10.48550/arXiv.2111.15602

M. Yin, T. X. Tran, A. Sharma, M. Mezzavilla, S. Rangan, "Demo: SkyRoute, a Fast and Realistic UAV Cellular Simulation Framework," in IEEE 29th International Conference on Network Protocols, 2021, pp. 1–2, doi: 10.1109/ICNP52444.2021.9651932

P. Skrimponis et al., "Understanding Energy Efficiency and Interference Tolerance in Millimeter Wave Receivers," in 55th Asilomar Conference on Signals, Systems, and Computers, 2021, pp. 645–651, doi: 10.1109/IEEECONF53345.2021.9723348

E. S. Lee, D. Shishika, G. Loianno, V. Kumar, "Defending a Perimeter from a Ground Intruder Using an Aerial Defender: Theory and Practice," in IEEE International Symposium on Safety, Security, and Rescue Robotics, 2021, pp. 184–189, doi: 10.1109/SSRR53300.2021.9597859

B. A. Blakeslee, G. Loianno, "Selective and Hierarchical Allocation of Sensing Resources for Anomalous Target Identification in Exploratory Missions," in IEEE International Symposium on Safety, Security, and Rescue Robotics, 2021, pp. 196–203, doi: 10.1109/SSRR53300.2021.9597688

S. R. Chintareddy, M. Mezzavilla, S. Rangan, M. Hashemi, "A preliminary assessment of midhaul links at 140 GHz using ray-tracing," in Proceedings of the 5th ACM Workshop on Millimeter-Wave and Terahertz Networks and Sensing Systems, Oct. 2021, pp. 25–30, doi: 10.1145/3477081.3481674

L. Righetti, J. Buchli, A. J. Ijspeert, "Slow-fast Dynamics of Strongly Coupled Adaptive Frequency Oscillators," in SIAM Journal on Applied Dynamical Systems, Oct. 2021, vol. 20, no. 4, pp. 1985–2012, doi: 10.1137/20M1357755

L. Sun, T. Zong, S. Wang, Y. Liu, Y. Wang, "Tightrope Walking in Low-latency Live Streaming: Joint Adaption of Video Rate and Playback Speed," in ACM Multimedia Systems Conference, Sep. 2021, doi: 10.1145/3458305.3463382

J. Mao, G. Li, S. Nogar, C. Kroninger, G. Loianno, "Aggressive Visual Perching with Quadrotors on Inclined Surfaces," in IEEE/RSJ International Conference on Intelligent Robots and Systems, 2021, pp. 5242–5248, doi: 10.1109/IROS51168.2021.9636690

P. Shah, A. Meduri, W. Merkt, M. Khadiv, I. Havoutis, L. Righetti, "Rapid Convex Optimization of Centroidal Dynamics using Block Coordinate Descent," in IEEE/RSJ International Conference on Intelligent Robots and Systems, 2021, pp. 1658–1665, doi: 10.1109/IROS51168.2021.9635856

R. Ge, G. Loianno, "VIPose: Real-time Visual-Inertial 6D Object Pose Tracking," in IEEE/RSJ International Conference on Intelligent Robots and Systems, 2021, pp. 4597–4603, doi: 10.1109/IROS51168.2021.9636283

V. Semkin et al., "Lightweight UAV-based Measurement System for Air-to-Ground Channels at 28 GHz," in IEEE 32nd Annual International Symposium on Personal, Indoor, and Mobile Radio Communications, 2021, pp. 848–853, doi: 10.1109/PIMRC50174.2021.9569561

W. Liu, K. Mohta, G. Loianno, et al., "Semi-dense visual-inertial odometry and mapping for computationally constrained platforms," in Autonomous Robot, Sept. 2021, vol. 45, pp. 773–787, doi: 10.1007/s10514-021-10002-z

A. Gazar, M. Khadiv, A. D. Prete, L. Righetti, "Stochastic and Robust MPC for Bipedal Locomotion: A Comparative Study on Robustness and Performance," in IEEE/RAS 20th International Conference on Humanoid Robots, 2021, pp. 61–68, doi: 10.1109/HUMANOIDS47582.2021.9555783

K. Jindal, A. Wang, D. Thakur, A. Zhou, V. Spurny, V. Walter, G. Broughton, T. Krajnik, M. Saska, G. Loianno, "Design and Deployment of an Autonomous Unmanned Ground Vehicle for Urban Firefighting Scenarios," in Field Robotics, Oct. 2021, doi: 10.55417/fr.2021007

B. Hammoud, M. Khadiv, L. Righetti, "Impedance Optimization for Uncertain Contact Interactions Through Risk Sensitive Optimal Control," in IEEE Robotics and Automation Letters, July 2021, vol. 6, no. 3, pp. 4766–4773, doi: 10.1109/LRA.2021.3068951

L. Sun, T. Zong, S. Wang, Y. Liu, Y. Wang, "Towards Optimal Low-Latency Live Video Streaming," in IEEE/ACM Transactions on Networking, Oct. 2021, vol. 29, no. 5, pp. 2327–2338, doi: 10.1109/TNET.2021.3087625

A. Khalili, S. Rangan, E. Erkip, "On Single-User Interactive Beam Alignment in Next Generation Systems: A Deep Learning Viewpoint," in IEEE International Conference on Communications Workshops, 2021, pp. 1–6, doi: 10.1109/ICCWorkshops50388.2021.9473733

O. Kanhere, T. S. Rappaport, "Outdoor sub-THz Position Location and Tracking Using Field Measurements at 142 GHz," in ICC/IEEE International Conference on Communications, 2021, pp. 1–6, doi: 10.1109/ICC42927.2021.9500482

R. Ranawat, A. Venkataraman, L. Subramanian, "CollectiveTeach: A System to Generate and Sequence Web-Annotated Lesson Plans," in COMPASS '21: ACM SIGCAS Conference on Computing and Sustainable Societies, June 2021, pp. 1–13, doi: 10.1145/3460112.3471938

T. Zong, L. Sun, Y. Liu, "Reinforced iLQR: A Sample-Efficient Robot Locomotion Learning," in IEEE International Conference on Robotics and Automation, 2021, pp. 5906–5913, doi: 10.1109/ICRA48506.2021.9561223

G. Li, A. Tunchez, G. Loianno, "PCMPC: Perception-Constrained Model Predictive Control for Quadrotors with Suspended Loads Using a Single Camera and IMU," in IEEE International Conference on Robotics and Automation, 2021, pp. 2012–2018, doi: 10.1109/ICRA48506.2021.9561449

T. Zong, C. Li, Y. Lei, G. Li, H. Cao, Y. Liu, "Cocktail Edge Caching: Ride Dynamic Trends of Content Popularity with Ensemble Learning," in IEEE INFOCOM Conference on Computer Communications, 2021, pp. 1–10, doi: 10.1109/INFOCOM42981.2021.9488910

Communications, Foundations & Machine Learning

I. Bizon, Q. Zhang, A. Kumar, A. Martinez, M. Chafii, G. Fettweis, "A Novel Approach for Cancellation of Non-Aligned Inter Spreading Factor Interference in LoRa Systems," in IEEE Open Journal of the Communications Society, April 2022

A. Chorti, A. Barreto, S. Kopsell, M. Zoli, M. Chafii, P. Sehier, G. Fettweis, V. Poor, "Context-Aware Security for 6G Wireless: The Role of Physical Layer Security," in IEEE Communications Standards Magazine, April 2022

M. Sigmund, R. Bomfin, M. Chafii, A. Nimr, G. Fettweis, "Waveform Design for Power-Domain Asynchronous NOMA," in IEEE VTC, Spring 2022

K. N. Alsowaina, S. F. Atashzar, D. R. Pur, R. Eagleson, R. V. Patel, A. I. Elnahas, J. D. Hawel, N. A. Alkhamesi, C. M. Schlachta, "Video Context Improves Performance in Identifying Operative Planes on Static Surgical Images," in Journal of Surgical Education, March–April 2022, vol. 79, no. 2, pp. 492–499, doi: 10.1016/j.jsurg.2021.10.004

M. Sigmund, R. Bomfin, M. Chafii, N. Ahmad, G. Fettweis, "Iterative Receiver for Power-Domain NOMA with Mixed Waveforms," in IEEE Wireless Communications and Networking Conference, April 2022

S. Ehsanfar, K. Moessner, A. K. Gizzini, M. Chafii, "Performance Comparison of IEEE 802.11p, 802.11bd-draft and a Unique-Word-based PHY in Doubly-Dispersive Channels," in IEEE Wireless Communications and Networking Conference, April 2022

A. A. Zarei, W. Jensen, A. F. Jadidi, E. R. Lontis, S. F. Atashzar, "Gamma-band enhancement of functional brain connectivity following transcutaneous electrical nerve stimulation," in Journal of Neural Engineering, March 2022, vol. 19, no. 2, pp. 026020, doi: 10.1088/1741–2552/ac59a1

A. K. Gizzini, M. Chafii, "Low Complex Methods for Robust Channel Estimation in Doubly Dispersive Environments," in IEEE Access, 2022, vol. 10, pp. 34321–34339, doi: 10.1109/ACCESS.2022.3162928

B. Shen, G. Coruzzi, D. Shasha, "An Adaptive Stacking Ensemble Approach to Network Inference Outperforms Any Single Method," in Scientific Reports, doi: 10.21203/rs.3.rs-1456294/v1 (accepted)

A. Pizzo, L. Sanguinetti, T. L. Marzetta, "Fourier Plane-Wave Series Expansion for Holographic MIMO Communications," in IEEE Transactions on Wireless Communications, 2022, doi: 10.1109/TWC.2022.3152965

E. Tyacke, S. P. J. Reddy, N. Feng, R. Edlabadkar, S. Zhou, J. Patel, Q. Hu, S. F. Atashzar, "Hand Gesture Prediction via Transient-phase sEMG Using Transfer Learning of Dilated Efficient CapsNet: Towards Generalization for Neurorobotics," in bioRxiv 2022.02.25.482002, March 2022, doi: 10.1101/2022.02.25.482002

G. Park, M. J. Balcer, J. R. Colcombe, L. Hasanaj, B. Joseph, R. Kenney, T. Hudson, J. R. Rizzo, J. C. Rucker, S. L. Galettta, L. J. Balcer, S. N. Grossman, "The MICK (mobile integrated cognitive kit) app: Digital rapid automatized naming for visual assessment across the spectrum of neurological disorders," in Journal of Neurological Sciences, March 2022, vol. 434, pp. 120150, doi: 10.1016/j.jns.2022.120150

R. Lourenço, J. Freire, E. Simon, G. Weber, D. Shasha, "BugDoc," in VLDB Journal, Feb. 2022, pp. 1–27, doi: 10.1007/s00778-022-00733-5

C. S. Mancero Castillo, R. Vaidyanathan, S. F. Atashzar, "Synergistic Upper-limb Functional Muscle Connectivity Using Acoustic Mechanomyography," in IEEE Transactions on Biomedical Engineering, 2022, doi: 10.1109/TBME.2022.3150422

R. O'Keeffe, S. Y. Shirazi, S. Bilaloglu, S. Jahed, R. Bighamian, P. Raghavan, S. F. Atashzar, "InfoMuNet: Information-theory-based Functional Muscle Network Tracks Sensorimotor Integration Post-stroke," in bioRxiv 2022.02.10.479324, Feb. 2022, doi: 10.1101/2022.02.10.479324

P. Hassanzadeh, et al., "Scalable delivery of correlated video content over cache-aided broadcast networks," in Edge Caching for Mobile Networks, Feb. 2022, pp. 119

S. Bakirtas, E. Erkip, "Database Matching Under Column Repetitions," in arXiv preprint arXiv:2202.01730, Feb. 2022, doi: 10.48550/arXiv.2202.01730

S. Bakirtas, E. Erkip, "Seeded Database Matching Under Noisy Column Repetitions," in arXiv preprint arXiv:2202.01724, Feb. 2022, doi: 10.48550/arXiv.2202.01724

M. Sahraee-Ardakan, M. Emami, P. Pandit, S. Rangan, A. K. Fletcher, "Kernel Methods and Multi-layer Perceptrons Learn Linear Models in High Dimensions," in arXiv preprint arXiv:2201.08082, Jan. 2022, doi: 10.48550/arXiv.2201.08082

A. Khalili, S. Shahsavari, M. A. A. Khojastepour, E. Erkip, "Optimal Single-User Interactive Beam Alignment with Feedback Delay," in arXiv preprint arXiv:2201.05751, Jan. 2022, doi: 10.48550/arXiv.2201.05751

S. Shahsavari, F. Shirani, M. A. Khojastepour, E. Erkip, "Opportunistic Temporal Fair Mode Selection and User Scheduling in Full-duplex Systems," in IEEE Journal on Selected Areas in Communications, 2022, doi: 10.1109/JSAC.2022.3143212

T. Sun, Q. Hu, J. Libby, S. F. Atashzar, "Deep Heterogeneous Dilation of LSTM for Transient-Phase Gesture Prediction Through High-Density Electromyography: Towards Application in Neurorobotics," in IEEE Robotics and Automation Letters, April 2022, vol. 7, no. 2, pp. 2851–2858, doi: 10.1109/LRA.2022.3142721

M. Shariatnasab, F. Shirani, E. Erkip, "Fundamental Privacy Limits in Bipartite Networks Under Active Attacks," in IEEE Journal on Selected Areas in Communications, March 2022, vol. 40, no. 3, pp. 940–954, doi: 10.1109/JSAC.2022.3142299

A. Le Xuan Mai, M. Mannino, Z. Tariq, A. Abouzied, D. Shasha, "EpiPolicy: a tool for combating epidemics," in XRDS: Crossroads, ACM Magazine for Students, Jan. 2022, vol. 28, no. 2, pp. 24–29, doi: 10.1145/3495257

P. Pandit, M. Sahraee-Ardakan, S. Rangan, P. Schniter, A. K. Fletcher, "Matrix inference and estimation in multi-layer models," in Journal of Statistical Mechanics: Theory and Experiment, Dec. 2021, vol. 2021, doi: 10.1088/1742-5468/ac3a75

A. W. Azim, J. L. G. Monsalve, M. Chafii, "Enhanced PSK-LoRa," in IEEE Wireless Communications Letters, March 2022, vol. 11, no. 3, pp. 612–616, doi: 10.1109/LWC.2021.3138914

P. Roszak et al., "Cell-by-cell dissection of phloem development links a maturation gradient to cell specialization," in Science, Dec. 2021, vol. 374, no. 6575, doi: 10.1126/science.aba5531

E. Erkip et al., "JSAIT Editorial for the Special Issue on "Beyond Errors and Erasures: Coding for Data Management and Delivery in Networks," in IEEE Journal on Selected Areas in Information Theory, Dec. 2021, vol. 2, no. 4, pp. 1075–1077, doi: 10.1109/JSAIT.2021.3133120

Q. Hu, A. Sarmadi, P. Gulati, P. Krishnamurthy, F. Khorrami, S. F. Atashzar, "X-MyoNET: Biometric Identification Using Deep Processing of Transient Surface Electromyography," in bioRxiv 2021.11.30.470688, Dec. 2021, doi: 10.1101/2021.11.30.470688

T. Lorieul, A. Joly, D. Shasha, "Classification Under Ambiguity: When Is Average-K Better Than Top-K?," in arXiv preprint arXiv:2112.08851, Dec. 2021, doi: 10.48550/arXiv.2112.08851

S. Datta, D. N. Amudala, E. Sharma, R. Budhiraja, S. S. Panwar, "Full-Duplex Cell-Free Massive MIMO Systems: Analysis and Decentralized Optimization," in IEEE Open Journal of the Communications Society, 2022, vol. 3, pp. 31–50, doi: 10.1109/OJCOMS.2021.3135153

A. K. Gizzini, M. Chafii, S. Ehsanfar, R. M. Shubair, "Temporal Averaging LSTM-based Channel Estimation Scheme for IEEE 802.11p Standard," in IEEE Global Communications Conference, 2021, pp. 1–7, doi: 10.1109/GLOBECOM46510.2021.9685409

A. Khalili, F. Shirani, E. Erkip, Y. C. Eldar, "MIMO Networks with One-Bit ADCs: Receiver Design and Communication Strategies," in IEEE Transactions on Communications, March 2022, vol. 70, no. 3, pp. 1580–1594, doi: 10.1109/TCOMM.2021.3133430

U. An, A. Bhardwaj, K. Shameer, L. Subramanian, "High Precision Mammography Lesion Identification from Imprecise Medical Annotations," in Frontiers in Big Data, Dec. 2021, vol. 4, doi: 10.3389/fdata.2021.742779

Y. Huang, Y. Liu, P. A. D. Steel, K. M. Axsom, J. R. Lee, S. L. Tummalapalli, F. Wang, J. Pathak, L. Subramanian, Y. Zhang, "Deep significance clustering: a novel approach for identifying risk-stratified and predictive patient subgroups," in Journal of the American Medical Informatics Association, Dec. 2021, vol. 28, no. 12, pp. 2641–2653, doi: 10.1093/jamia/ocab203

O. Yildiz, A. Khalili, E. Erkip, "Hybrid Beam Alignment for Multi-Path Channels: A Group Testing Viewpoint," in arXiv preprint arXiv:2111.08159, Nov. 2021, doi: 10.48550/arXiv.2111.08159

M. Yemini, E. Erkip, A. J. Goldsmith, "Interference Reduction in Virtual Cell Optimization," in 55th Asilomar Conference on Signals, Systems, and Computers, 2021, pp. 18–25, doi: 10.1109/IEEECONF53345.2021.9723136

E. Rahimian, S. Zabihi, A. Asif, D. Farina, S. F. Atashzar, A. Mohammadi, "Hand Gesture Recognition Using Temporal Convolutions and Attention Mechanism," in arXiv preprint arXiv:2110.08717, Oct. 2021

A. Karim Gizzini, M. Chafii, A. Nimr, R. M. Shubair, G. Fettweis, "CNN Aided Weighted Interpolation for Channel Estimation in Vehicular Communications," in IEEE Transactions on Vehicular Technology, Dec. 2021, vol. 70, no. 12, pp. 12796–12811, doi: 10.1109/TVT.2021.3120267

Y. Liu, U. Yoo, S. Ha, S. F. Atashzar, F. Alambeigi, "Influence of Antagonistic Tensions on Distributed Friction Forces of Multisegment Tendon-Driven Continuum Manipulators with Irregular Geometry," in IEEE/ASME Transactions on Mechatronics, 2021, doi: 10.1109/TMECH.2021.3112580

Z. Fan, J. Liu, Y. Wang, "Motion Adaptive Pose Estimation from Compressed Videos," in IEEE/CVF International Conference on Computer Vision, 2021, pp. 11699–11708, doi: 10.1109/ICCV48922.2021.01151

R. O'Keeffe, S. Y. Shirazi, J. Yang, S. Mehrdad, S. Rao, S. F. Atashzar, "Non-parametric Functional Muscle Network as a Robust Biomarker of Fatigue," in bioRxiv 2021.09.29.462080, Oct. 2021, doi: 10.1101/2021.09.29.462080

A. Boldini, A. L. Garcia, M. Sorrentino, M. Beheshti, O. Ogedegbe, Y. Fang, M. Porfiri, J. R. Rizzo, "An Inconspicuous, Integrated Electronic Travel Aid for Visual Impairment," in ASME Letters in Dynamic Systems and Control, Oct. 2021, vol. 1, no. 4, doi: 10.1115/1.4050186

Z. Tariq, M. Mannino, M. Le Xuan Anh, W. Bagge, A. Abouzied, D. Shasha, "Planning Epidemic Interventions with EpiPolicy," in 34th Annual ACM Symposium on User Interface Software and Technology, Oct. 2021, pp. 894–909, doi: 10.1145/3472749.3474794

N. Patel, S. Krishna, D. Shasha, T. Wies, "Verifying concurrent multicopy search structures," in Proceedings of the ACM on Programming Languages, Oct. 2021, vol. 5, issue OOPSLA, pp. 1–32, doi: 10.1145/3485490

T. T. Vu, H. Quoc Ngo, T. L. Marzetta, M. Matthaiou, "How Does Cell-Free Massive MIMO Support Multiple Federated Learning Groups?," in IEEE 22nd International Workshop on Signal Processing Advances in Wireless Communications, 2021, pp. 401–405, doi: 10.1109/SPAWC51858.2021.9593248

J. Robin, E. Erkip, "Access Delay Constrained Activity Detection in Massive Random Access," in IEEE 22nd International Workshop on Signal Processing Advances in Wireless Communications, 2021, pp. 191–195, doi: 10.1109/SPAWC51858.2021.9593173

F. Carpi, S. Garg, E. Erkip, "Single-Shot Compression for Hypothesis Testing," in IEEE 22nd International Workshop on Signal Processing Advances in Wireless Communications, 2021, pp. 176–180, doi: 10.1109/SPAWC51858.2021.9593264

E. Rahimian, S. Zabihi, A. Asif, D. Farina, S. F. Atashzar, A. Mohammadi, "TEMGNet: Deep Transformer-based Decoding of Upperlimb sEMG for Hand Gestures Recognition," in arXiv preprint arXiv:2109.12379, Sep. 2021

R. O'Keeffe, S. Y. Shirazi, S. Mehrdad, T. Crosby, A. M. Johnson, S. F. Atashzar, "Characterization of Cervical-Cranial Muscle Network in Correlation with Vocal Features," in bioRxiv 2021.09.23.461177, Sep. 2021, doi: 10.1101/2021.09.23.461177

A. Pizzo, A. de Jesus Torres, L. Sanguinetti, T. L. Marzetta, "Nyquist-Sampling and Degrees of Freedom of Electromagnetic Fields," in arXiv preprint arXiv:2109.10040, Sep. 2021, doi: 10.48550/arXiv.2109.10040

D. Sheng et al., "NYU-VPR: Long-Term Visual Place Recognition Benchmark with View Direction and Data Anonymization Influences," in IEEE/RSJ International Conference on Intelligent Robots and Systems, 2021, pp. 9773–9779, doi: 10.1109/IROS51168.2021.9636640

S. Shahsavari, M. Nosrati, P. Hassanzadeh, A. Ashikhmin, T. L. Marzetta, E. Erkip, "Multi-Point Coordination in Massive MIMO Systems with Sectorized Antennas," in IEEE Transactions on Communications, Nov. 2021, vol. 69, no. 11, pp. 7559–7575, doi: 10.1109/TCOMM.2021.3104225

Y. Wang et al., "On Future Development of Autonomous Systems: A Report of the Plenary Panel at IEEE ICAS '21," in IEEE International Conference on Autonomous Systems, 2021, pp. 1–9, doi: 10.1109/ICAS49788.2021.9551188

E. Rahimian, S. Zabihi, A. Asif, S. F. Atashzar, A. Mohammadi, "Trustworthy Adaptation with Few-Shot Learning for Hand Gesture Recognition," in IEEE International Conference on Autonomous Systems, 2021, pp. 1–5, doi: 10.1109/ICAS49788.2021.9551144

A. Altelbani, H. Zhou, S. Mehrdad, F. Alambeigi, S. F. Atashzar, "Design, Fabrication, and Validation of a New Family of 3D-Printable Structurally-Programmable Actuators for Soft Robotics," in IEEE Robotics and Automation Letters, Oct. 2021, vol. 6, no. 4, pp. 7941–7948, doi: 10.1109/LRA.2021.3101860

A. Balashankar, L. Subramanian, "Learning Faithful Representations of Causal Graphs," in Proceedings of the 59th Annual Meeting of the Association for Computational Linguistics and the 11th International Joint Conference on Natural Language Processing, Association for Computational Linguistics, Aug. 2021, vol. 1: Long Papers, pp. 839–850, doi: 10.18653/v1/2021.acl-long.69

H. Liu et al., "Neural Video Coding Using Multiscale Motion Compensation and Spatiotemporal Context Model," in IEEE Transactions on Circuits and Systems for Video Technology, Aug. 2021, vol. 31, no. 8, pp. 3182–3196, doi: 10.1109/TCSVT.2020.3035680

M. Bernardinis, S. F. Atashzar, R. V. Patel, M. S. Jog, "Abnormal Vision-Based Displacement Perception in Parkinson's Disease," in Frontiers in Neuroscience, July 2021, vol. 15, 676469, doi: 10.3389/fnins.2021.676469

L. Galanti, D. Shasha, K. C. Gunsalus, "Pheniqs 2.0: accurate, high-performance Bayesian decoding and confidence estimation for combinatorial barcode indexing," in BCM Bioinformatics, July 2021, vol. 22, no. 1, pp. 1–16, doi: 10.1186/s12859-021-04267-5

M. Sahraee-Ardakan, T. Mai, A. Rao, R. A. Rossi, S. Rangan, A. K. Fletcher, "Asymptotics of Ridge Regression in Convolutional Models," in Proceedings of the 38th International Conference on Machine Learning, in Proceedings of Machine Learning Research, July 2021, vol. 139, pp. 9265–9275

M. Emami, M. Sahraee-Ardakan, P. Pandit, S. Rangan, A. K. Fletcher, "Implicit Bias of Linear RNNs," in Proceedings of the 38th International Conference on Machine Learning, in Proceedings of Machine Learning Research, July 2021, vol. 139, pp. 2982–2992

Z. Qiu et al., "A Deep Learning Approach for Segmentation, Classification, and Visualization of 3-D High-Frequency Ultrasound Images of Mouse Embryos," in IEEE Transactions on Ultrasonics, Ferroelectrics, and Frequency Control, July 2021, vol. 68, no. 7, pp. 2460–2471, doi: 10.1109/TUFFC.2021.3068156

Z. Yuan, H. Liu, D. Mukherjee, B. Adsumilli, Y. Wang, "Block-based Learned Image Coding with Convolutional Autoencoder and Intra-Prediction Aided Entropy Coding," in Picture Coding Symposium, 2021, pp. 1–5, doi: 10.1109/PCS50896.2021.9477503

T. Sun, Q. Hu, P. Gulati, S. F. Atashzar, "Temporal Dilation of Deep LSTM for Agile Decoding of sEMG: Application in Prediction of Upper-Limb Motor Intention in NeuroRobotics," in IEEE Robotics and Automation Letters, Oct. 2021, vol. 6, no. 4, pp. 6212–6219, doi: 10.1109/LRA.2021.3091698

D. Jiménez-Grande, S. F. Atashzar, E. Martinez-Valdes, D. Falla, "Muscle network topology analysis for the classification of chronic neck pain based on EMG biomarkers extracted during walking," in PLoS ONE 16(6): e0252657, June 2021, doi: 10.1371/journal.pone.0252657

R. Jess Williams, P. Ramírez-Espinosa, E. de Carvalho, T. L. Marzetta, "Multiuser MIMO with Large Intelligent Surfaces: Communication Model and Transmit Design," in ICC/IEEE International Conference on Communications, 2021, pp. 1–6, doi: 10.1109/ICC42927.2021.9500830

S. Datta, E. Sharma, D. N. Amudala, R. Budhiraja, S. S. Panwar, "FD Cell-Free mMIMO: Analysis and Optimization," in ICC/IEEE International Conference on Communications, 2021, pp. 1–6, doi: 10.1109/ICC42927.2021.9500917

E. Rahimian, S. Zabihi, A. Asif, S. F. Atashzar, A. Mohammadi, "Few-Shot Learning for Decoding Surface Electromyography for Hand Gesture Recognition," in ICASSP/IEEE International Conference on Acoustics, Speech, and Signal Processing, 2021, pp. 1300–1304, doi: 10.1109/ICASSP39728.2021.9413582

S. Krishna, N. Pate, D. Shasha, T. Wies, "Automated Verification of Concurrent Search Structures," Morgan Claypool Synthesis Lectures on Computer Science, June 2021, doi: 10.2200/S01089ED1V01Y202104CSL013

N. Feizi, S. Thudi, R. V. Patel, S. F. Atashzar, "Time-Domain Passivity-based Controller with an Optimal Two-channel Lawrence Telerobotic Architecture," in IEEE International Conference on Robotics and Automation, 2021, pp. 3865–3871, doi: 10.1109/ICRA48506.2021.9561930

Z. Chen, R. Wang, H. Liu, Y. Wang, "PDWN: Pyramid Deformable Warping Network for Video Interpolation," in IEEE Open Journal of Signal Processing, 2021, vol. 2, pp. 413–424, 2021, doi: 10.1109/OJSP.2021.3075879

Mobile Edge & Low Latency Networking

M. Chaqfeh, M. Haseeb, W. Hashmi, P. Inshuti, M. Ramesh, M. Varvello, L. Subramanian, F. Zaffar, Y. Zaki, "To Block or Not to Block: Accelerating Mobile Web Pages On-the-Fly Through JavaScript Classification," in Proceedings of the 12th International Conference on Information and Communication Technologies and Development, June 2022 (accepted)

W. Hashmi, M. Chaqfeh, L. Subramanian, Y. Zaki, "QLUE: A Computer Vision Tool for Uniform Qualitative Evaluation of Web Pages," in Proceedings of the Web Conference, April 2022, doi: 10.1145/3485447.3512112

Z. Yuan et al., "Network-Aware 5G Edge Computing for Object Detection: Augmenting Wearables to 'See' More, Farther, and Faster," in IEEE Access, 2022, vol. 10, pp. 29612–29632, doi: 10.1109/ACCESS.2022.3157876

Y. Zaki, R. Asim, M. Khan, S. Iyer, T. Ahmad, T. Potsch, L. Subramanian, "ALCC: Migrating Congestion Control to the Application Layer in Cellular Networks," in Journal of Systems Research, March 2022, vol. 2, no. 1, doi: 10.5070/SR32156656

C. Tunc, S. S. Panwar, "Mitigating the Impact of Blockages in Millimeter-Wave Vehicular Networks Through Vehicular Relays," in IEEE Open Journal of Intelligent Transportation Systems, 2021, vol. 2, pp. 225–239, doi: 10.1109/OJITS.2021.3100856

R. Bhatia, T. V. Lakshman, M. F. Özkoç, S. Panwar, "FlowToss: Fast Wait-Free Scheduling of Deterministic Flows in Time Synchronized Networks," in IFIP Networking Conference, 2021, pp. 1–6, doi: 10.23919/IFIPNetworking52078.2021.9472838

B. Keita, A. Srivastava, F. Fund, S. S. Panwar, "A controlled, reproducible, and extensible experiment for evaluating the impact of Tor latency," in IEEE/INFOCOM Conference on Computer Communications Workshops, 2021, pp. 1–2, doi: 10.1109/INFOCOMWKSHPS51825.2021.9484448

D. Roberts, A. Srivastava, F. Fund, S. S. Panwar, "Tackling the latency divide with Copa," in IEEE/INFOCOM Conference on Computer Communications Workshops, 2021, pp. 1–2, doi: 10.1109/INFOCOMWKSHPS51825.2021.9484571

Quantum Devices & Circuits

Z. Cheng, C. S. Pang, P. Wang, S. T. Le, Y. Wu, D. Shahrjerdi, I. Radu, M. C. Lemme, L. M. Peng, X. Duan, Z. Chen, J. Appenzeller, S. J. Koester, E. Pop, A. D. Franklin, C. A. Richter, "How to Report and Benchmark Emerging Field-Effect Transistors," in arXiv preprint arXiv:2203.16759, March 2022, doi: 10.48550/arXiv.2203.16759

Z. Huang, E. Cuniberto, S. Park, K. Kisslinger, Q. Wu, T. Taniguchi, K. Watanabe, K. G. Yager, D. Shahrjerdi, "Mechanisms of Interface Cleaning in Heterostructures Made from Polymer-Contaminated Graphene," in Small, 2022, doi: 10.1002/smll.202201248

D. Shakya, T. Wu, M. E. Knox, T. S. Rappaport, "A Wideband Sliding Correlation Channel Sounder in 65 nm CMOS: Evaluation Board Performance," in IEEE Transactions on Circuits and Systems II: Express Briefs, Sept. 2021, vol. 68, no. 9, pp. 3043–3047, doi: 10.1109/TCSII.2021.3087032

Testbeds & Prototyping

A. Chopra, A. Thornburg, O. Kanhere, S. S. Ghassemzadeh, M. Majumdar, T. S. Rappaport, "A Real-Time Millimeter Wave V2V Channel Sounder," in IEEE Wireless Communications and Networking Conference, April 2022, pp. 1–6

T. Chen, P. Maddala, P. Skrimponis, J. Kolodziejski, X. Gu, A. Paidimarri, S. Rangan, G. Zussman, I. Seskar, "Programmable and Open-Access Millimeter-Wave Radios in the PAWR COSMOS Testbed," in Proceedings of the 15th ACM Workshop on Wireless Network Testbeds, Experimental Evaluation & Characterization, Jan. 2022, pp. 1–8, doi: 10.1145/3477086.3480834

N. Akram et al., "Frequency-Multiplexed Array Digitization for MIMO Receivers: 4-Antennas/ADC at 28 GHz on Xilinx ZCU-1285 RF SoC," in IEEE Access, 2021, vol. 9, pp. 142743–142753, doi: 10.1109/ACCESS.2021.3120704

A. Dhananjay, K. Zheng, M. Mezzavilla, L. Iotti, D. Shasha, S. Rangan, "Pi-Radio v1: Calibration techniques to enable fully-digital beamforming at 60 GHz," in Computer Networks, Sept. 2021, vol. 196, pp. 108220, doi: 10.1016/j.comnet.2021.108220

N. Akram, V. Ariyarathna, S. Mandal, L. Belostotski, T. S. Rappaport, A. Madanayake, "Spacetime Frequency-Multiplexed Digital-RF Array Receivers with Reduced ADC Count," in IEEE Transactions on Circuits and Systems II: Express Briefs, Aug. 2021, vol. 68, no. 8, pp. 2840–2844, doi: 10.1109/TCSII.2021.3073059

Terahertz (THz) Communications & Sensing

Y. Xing, O. Kanhere, S. Ju, T. S. Rappaport, "Sub-Terahertz Wireless Coverage Analysis at 142 GHz in Urban Microcell," in IEEE International Conference on Communications, May 2022, pp. 1–6

S. Ju, Y. Xing, O. Kanhere, T. S. Rappaport, "Sub-Terahertz Channel Measurements and Characterization in a Factory Building," in IEEE International Conference on Communications, May 2022, pp. 1–6

S. Ju, T. S. Rappaport, "Sub-Terahertz Spatial Statistical MIMO Channel Model for Urban Microcells at 142 GHz," in IEEE Global Communications Conference, Dec. 2021, pp. 1–6, doi: 10.1109/GLOBECOM46510.2021.9685929

Y. Xing, T. S. Rappaport, "Millimeter Wave and Terahertz Urban Microcell Propagation Measurements and Models," in IEEE Communications Letters, Dec. 2021, vol. 25, no. 12, pp. 3755–3759, doi: 10.1109/LCOMM.2021.3117900

Y. Xing, T. S. Rappaport, A. Ghosh, "Millimeter Wave and Sub-THz Indoor Radio Propagation Channel Measurements, Models, and Comparisons in an Office Environment," in IEEE Communications Letters, Oct. 2021, vol. 25, no. 10, pp. 3151–3155, doi: 10.1109/LCOMM.2021.3088264

Y. Xing, T. S. Rappaport, "Terahertz Wireless Communications: Co-Sharing for Terrestrial and Satellite Systems Above 100 GHz," in IEEE Communications Letters, Oct. 2021, vol. 25, no. 10, pp. 3156–3160, doi: 10.1109/LCOMM.2021.3088270

S. Ju, T. S. Rappaport, "140 GHz Urban Microcell Propagation Measurements for Spatial Consistency Modeling," in –ICC/IEEE International Conference on Communications, 2021, pp. 1–6, doi: 10.1109/ICC42927.2021.9500677

Dante Youla Award

Fabrizio Carpi, a student of NYU WIRELESS professors Elza Erkip and Siddharth Garg, received the 2022 Dante Youla Award, an honor given in memory of ECE Professor Emeritus Dante Youla, who passed away in August 2021. The award recognizes Ph.D. students who make important research contributions to the field, either as the principal author of an impactful paper or as the recipient of a significant external award. Pictured (l. to r.) are fellow award winners Linan Huang, Leilei Cui, ECE Department Chairman Professor Ivan Selesnick, Fabrizio, and Guanrui Li.

NYU WIRELESS
NYU Tandon School of Engineering
370 Jay Street, 9th Floor
Brooklyn, NY 11201
646-997-3403
nyuwireless.com

Nonprofit Org.
U.S. Postage
PAID
Milford, CT
Permit 80

Address Service Requested

NYU WIRELESS Newsletter

Download and read copies of our previous newsletters online by visiting **nyuwireless.com/nyu-wireless-newsletter**

@NYUWIRELESS NYU WIRELESS NYU WIRELESS

NYU WIRELESS Industrial Affiliate Members

NYU WIRELESS

ANALOG DEVICES
AHEAD OF WHAT'S POSSIBLE™

CACI
EVER VIGILANT

CROWN CASTLE

DELL Technologies

ERICSSON

interdigital

MEDIATEK

NEC

NOKIA

QUALCOMM

SHARP

SONY

T-Mobile

UMC