ECE MAGAZINE 2024

Northeastern University
Electrical and Computer Engineering

Northeastern University
College of Engineering

With over 240 tenured/tenure-track faculty and 20 multidisciplinary research centers and institutes with funding by eight federal agencies, the College of Engineering is a leader in experiential education and interdisciplinary research focused on discovering solutions to global challenges to benefit society. Northeastern's global university system—with engineering programs on campuses across the U.S. and in multiple countries—provides flexible academic offerings, innovative partnerships, and the ability to scale ideas, talent, and solutions.

About Northeastern

Founded in 1898, Northeastern is a global research university and the recognized leader in experiential lifelong learning. Our approach of integrating real-world experience with education, research, and innovation empowers our students, faculty, alumni, and partners to create worldwide impact.

Northeastern's personalized, experiential undergraduate and graduate programs lead to degrees through the doctorate in 10 colleges and schools across our 13 campuses worldwide. Learning emphasizes the intersection of data, technology, and human literacies, uniquely preparing graduates for careers of the future and lives of fulfillment and accomplishment.

Our research enterprise, with an R1 Carnegie classification, is solutions oriented and spans the world. Our faculty scholars and students work in teams that cross not just disciplines, but also sectors—aligned around solving today's highly interconnected global challenges and focused on transformative impact for humankind.

coe.northeastern.edu

Letter From the Chair

Photo by Matthew Modoono

DEAR COLLEAGUES, FRIENDS, AND STUDENTS,

It is my pleasure to address all of you as the interim chair of the Department of Electrical and Computer Engineering (ECE) at Northeastern University. On January 1, 2025, Edmund Yeh, professor of electrical and computer engineering, will take the helm as our permanent department chair.

Our ECE department continues to move to new heights and set new standards within Northeastern. In FY2024, our faculty received more than $52 million in external research awards, primarily from the National Science Foundation, the Department of Defense, and the Department of Commerce, among many others. Our accomplished faculty received prestigious honors, including being elected to the American Academy of Arts and Sciences, and several being named fellows and distinguished members of professional societies. On the junior faculty side, four of our assistant professors received early-career awards from the NSF and DARPA.

The number and caliber of our students continue to rise. During the 2023-2024 academic year, the department had 830 undergraduate students, and at the graduate level enrollment reached 618 master's and 322 doctoral students–a record for the department. While most of our graduate students are based in Boston, we see a growing presence at our Seattle campus. Additionally, we recently created new programs, including a concentration, minor, and MS in semiconductor engineering, with the master's program planned to be launched at both our Boston and Oakland campuses. Our semiconductor programs address the national demand for a highly skilled workforce aligned with the goals of the CHIPS Act.

Our students have had many achievements. In the last year, two of our PhD students received the U.S. National Defense Science and Engineering Graduate Research Fellowship, another was selected as a NASA Space Technology Graduate Research Fellow, and one received the ACM/IEEE CS George Michael Memorial HPC Fellowship, while many others received Best Paper Awards and won competitions at professional society conferences.

To support the growth of our academic programs, the department continues to hire outstanding faculty across the network. Six tenure-track faculty joined our department for the 2024-2025 academic year, including two based at our Oakland campus, and four joint with other colleges at Northeastern. With these colleagues on board, the department today has 90 tenured and tenure-track faculty, 14 teaching faculty, and 12 research faculty. This makes ECE one of the most comprehensive ECE departments in the country. This is in part reflected by the latest graduate rankings by the U.S. News and World Report: 35 and 29 for electrical and computer engineering, respectively.

Last but not least, the department has 12 dedicated staff members who ensure day-to-day operations and help faculty and students realize their vision and goals.

Sincerely,

Josep Miquel Jornet, PhD and IEEE Fellow
Professor and Interim Chair of Electrical and Computer Engineering
j.jornet@northeastern.edu

For more details, visit our website at ECE.NORTHEASTERN.EDU.

Quick Facts ELECTRICAL AND COMPUTER ENGINEERING

322
Doctoral Students
Fall 2024

619
Master's Students
Fall 2024

830
Bachelor's Students
Fall 2024

3
Campuses
Boston, Seattle, Oakland

114
Total Faculty
Fall 2024

45
Professional Society Fellowships

27
National Science Foundation
CAREER Awards

62
Young Investigator Awards

Ali Abur
Professor

Member of the **National Academy of Engineering**

$52M
External Research Awards
FY2024

3
IEEE Society Counsel Presidents

#35
Electrical Engineering
US News & World Report 2025

#29
Computer Engineering
US News & World Report 2025

COLLEGE OF ENGINEERING
#38
Best Graduate Engineering Schools
US News & World Report 2025

COLLEGE OF ENGINEERING
#35
Best Undergraduate Engineering Schools
US News & World Report 2025

AY2024 Young Investigator Awards

Siddhartha Ghosh
Assistant Professor
NSF CAREER and DARPA Young Faculty Award

Aatmesh Shrivastava
Associate Professor
DARPA Young Faculty Award

Alireza Ramezani
Assistant Professor
NSF CAREER Award

Lili Su
Assistant Professor
NSF CAREER Award

Kristina Johnson
Assistant Professor
NIH Career Development Award

The department offers **8** research concentrations and is either the lead or partner of **12** federally-funded research centers and institutes.

NEWEST RESEARCH CENTERS AND INSTITUTES

Externally established centers, with external partners:

- DHS Software target Engineering to Neutralize the Threat Reality
- NSF AI Institute for Future Edge Networks and Distributed Intelligence
- NSF Center for Pandemic Insights
- NSF IUCRC Center for Hardware and Embedded Systems Security and Trust

Internally established institutes:

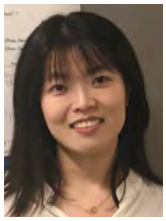
- Institute for Experiential AI
- Institute for Experiential Robotics
- Institute for NanoSystems Innovation
- Institute for the Wireless Internet of Things

New Tenure-Track Faculty

PRIMARY APPOINTMENT: ELECTRICAL AND COMPUTER ENGINEERING

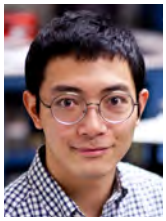
Aravind Nagulu *Assistant Professor*

PhD: Columbia University, 2021
Previously: Assistant Professor, Washington University
Scholarship focus: Analog/RF/millimeter-wave integrated circuits and systems, analog computing, biomedical scanners, and hardware for large-scale quantum computing systems
Campus: Oakland, California



Weiyan Shi *Assistant Professor*

Jointly appointed: Khoury College of Computer Sciences
PhD: Columbia University, 2023
Previously: Postdoc, Stanford University
Scholarship focus: Persuasive dialogues, dialogue systems, natural language processing, AI safety, machine learning, artificial intelligence
Campus: Boston



Yuan Yuan *Assistant Professor*

PhD: University of Virginia, 2019
Previously: Sr. Research Scientist, Hewlett Packard Labs
Scholarship focus: Optoelectronic devices, single-photon detection, silicon photonics, large-scale photonic integrated circuits for interconnects and computing
Campus: Oakland, California

PRIMARY APPOINTMENT: OTHER NORTHEASTERN COLLEGE

Ivana Dimitrova *Assistant Professor*

Jointly appointed: Physics
PhD: Massachusetts Institute of Technology, 2020
Previously: Postdoctoral Fellow, Harvard University
Scholarship focus: Quantum networking and quantum computing with atoms in optical tweezer arrays, cavity QED, many-body states
Campus: Boston

Seth Hutchinson *Professor*

Jointly appointed: Khoury College of Computer Sciences
PhD: Purdue University, 1988
Previously: Professor and KUKA Chair for Robotics in the School of Interactive Computing, and Executive Director of the Institute for Robotics and Intelligent Machines, Georgia Institute of Technology
Scholarship focus: Robotics: planning, sensing, control, human-robot interaction, bio-inspired robotics, multi-robot systems
Campus: Boston

David Sherman *Assistant Professor*

Jointly appointed: Physical Therapy, Movement, and Rehabilitation
PhD: University of Toledo, 2022
DPT: Boston University, 2014
Previously: Postdoctoral Fellow, Harvard John A. Paulson School of Engineering
Scholarship focus: Movement neuroscience, sensorimotor physiology, clinical research, orthopedics, rehabilitation
Campus: Boston

3D Imaging Breakthrough To Radically Improve Early Detection of Lung Cancer

Soner Sonmezoglu, an assistant professor of electrical and computer engineering, was awarded up to $13.3 million from the Advanced Research Projects Agency for Health (ARPA-H) and will lead a multi-institutional team to develop an innovative electronic-photonic photoacoustic imaging system for accurate assessment and identification of early-stage lung cancer.

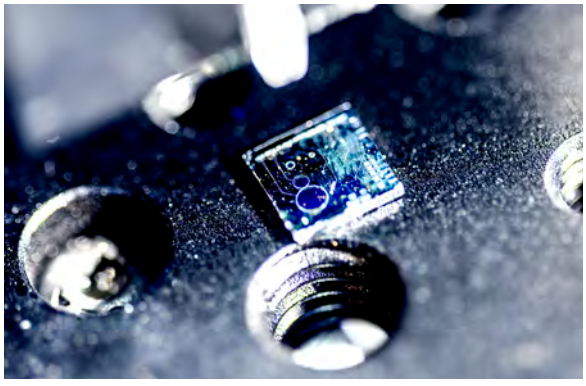
The system is expected to transform the landscape of the photoacoustic imaging field by providing real-time and high-contrast volumetric images that can assist in diagnosing and treating lung cancer, and, ultimately, contribute to treating other major diseases.

Lung cancer, the leading cause of cancer death globally and in the U.S., accounts for about one in five of all cancer deaths. Early detection and treatment of lung cancer is essential to optimize patient survival; minimally invasive carcinoma has a higher than 90 percent five-year survival, whereas invasive carcinomas have less than a fifty-five-year survival. Low-dose computed tomography, currently used for early cancer diagnosis in at-risk populations, is highly sensitive for detecting lung nodules but has low specificity for the identification of small, early-stage malignant lung nodules.

There is a critical urgent need to develop minimally invasive in vivo imaging technologies capable of providing microscopic assessment and identification of malignancy at the early stages of lung cancer In response, the research team will develop a unique system that enables volumetric microscopic visualization of structural and functional information in vivo at centimeter-scale depths. This currently unavailable information at great depths will allow for the differentiation of early-stage lung nodules in vivo.

The goal is a radically new, miniaturized optical photoacoustic imaging system with advanced image reconstruction algorithms. During the five-year program, the team will focus on lung cancer as the proof-of-concept demonstration.

The commercialization of this imaging technology will have broad societal impacts since it can provide ample opportunities to improve diagnosis, personalized treatment plans, and, eventually, patient outcomes. The Northeastern University team includes pathologists, surgeons, and engineers from Massachusetts General Hospital,Johns Hopkins University, and the University of Washington. △



Soner Sonmezoglu, assistant professor of electrical and computer engineering, works in the Interdisciplinary Science and Engineering Complex at Northeastern to develop an innovative electronic-photonic photoacoustic imaging system for accurate assessment and identification of lung cancer at an early stage.

All photos by Matthew Modoono

Unlocking Innovation in Next-Generation Wireless Networks

Tommaso Melodia
Photo by Alyssa Stone

The Open6G Open Testing and Integration Center (OTIC) at Northeastern's Institute for the Wireless Internet of Things (WIoT), under the direction of **Tommaso Melodia**, the institute's director and William Lincoln Smith and ECE professor, is spearheading multiple projects that support the Open Radio Access Network (RAN), an industry standard set to revolutionize the deployment, management, and optimization of wireless mobile networks.

The programs have been funded by the National Telecommunications and Information Administration's Public Wireless Supply Chain Innovation Fund, a $1.5 billion funding source allocated by the CHIPS and Science Act of 2022, and include:

End-to-End Automation: Through the AutoRAN NTIA award, the Open6G team is addressing a fundamental challenge that could hinder the progress of Open RAN systems: the integration and testing of 5G base station components from multiple vendors. This is crucial for building a robust and innovative supply chain but is often associated with costly and labor-intensive processes. AutoRAN, led by ECE Assistant Research Professor **Michele Polese**, leverages the team's expertise in automation and AI to streamline this process, transforming validation in a multi-vendor environment into a plug-and-play operation.

Digital Twinning: As part of the DigiRAN NTIA award, the Open6G team is pioneering new methodologies to develop high-fidelity, real-time Digital Twins of Wireless Networks. DigiRAN, led by ECE Principal Research Scientist **Pedram Johari**, will utilize Northeastern's Colosseum wireless network emulator to facilitate end-to-end testing and evaluation of the performance and interoperability of Open RAN systems.

Energy Efficiency: Efficient information processing is essential for advancing software-driven, open, and programmable networks. Through the TENORAN NTIA award, led by ECE Associate Research Professor **Salvatore D'Oro**, the Open6G team is enhancing 5G) testing capabilities by conducting fine-grained energy consumption evaluations for Open RAN systems. This project was the first to receive funding from the Innovation Fund, and was recognized with a public ceremony at Northeastern in 2023. It supports sustainability initiatives and identifies repeatable, programmatic testing procedures to optimize energy efficiency across multi-vendor and vertical systems.

Artificial Intelligence for Open and Programmable Networks: The three aforementioned NTIA awards will be a valuable addition to the Northeastern University's Open6G research, development, and testing portfolio, initiated in 2022 and seed funded by OUSD (R&E), as well as the research sponsored by the O-RAN ALLIANCE toward leveraging artificial intelligence techniques for the control and optimization of Open RAN systems.

The Open6G Open Testing and Integration Center (OTIC) is a key participant in the AT&T and Verizon ACCoRD framework, which is testing and integrating commercial Open RAN equipment from leading vendors. The Open6G team can also certify commercial equipment as Open RAN-complaint because it is officially recognized by the O-RAN ALLIANCE, the industry body leading Open RAN development. The OTIC, which already collaborates with commercial partners, is supported by WIoT and the MassTech Collaborative.

Additionally, the Open6G team is also leading several outreach activities including PlugFests, tutorials, and demos at leading academic and industry events and workshops. It organized the first Workshop on Research and Innovation in Testing and Integration for Open Radio Access Networks (RitiRAN), to bring together researchers from academia, industry, and government to advance Open RAN testing and integration.

Northeastern's Open RAN program has been awarded more than $25 million in funding from federal and state agencies and more than 20 industry partners. It is also supported by a consortium of telecom operators, vendors, and integrators, including Qualcomm, InterDigital, Mavenir, MITRE, NVIDIA, Keysight, Viavi, Raytheon, Red Hat, AT&T.

The research has resulted in over 50 publications, with several receiving best paper awards at top conferences, including IEEE INFOCOM 2022, IEEE VNC 2024, and IEEE NG-OPERA 2024. △

Sarah Ostadabbas
Photo by Matthew Modoono

Computer Vision, Small Data, and Women in Engineering: A Vision Towards Accessibility and Equity

In today's world, cameras are ubiquitous, and processing this visual information effectively requires advanced computer vision technologies. **Sarah Ostadabbas**, associate professor of electrical and computer engineering and the director of the Women in Engineering Program at Northeastern, leads the Augmented Cognition Lab, which focuses on training computers to understand and predict human and animal behaviors through tasks such as object modeling, tracking, and action recognition.

The lab aims to enhance human capabilities in interpreting visual data rather than replace them directly supporting Ostadabbas's vision of making advanced technologies accessible and ensuring they augment human abilities, which will foster equity in technological applications.

Advanced machine learning (ML) and computer vision (CV) models often require large datasets, posing challenges in scenarios where data acquisition is limited by cost, privacy, or security, or what Ostadabbas refers to as small data. Her lab's approach incorporates domain knowledge into the learning process through generative models and data-efficient ML techniques, democratizing AI and ensuring that even underrepresented groups and resource-constrained domains benefit from these technologies. This approach promotes inclusivity, equity, and fairness in AI applications.

Ostadabbas is dedicated to addressing challenges faced by vulnerable populations, ensuring that technological advancements benefit all, particularly those historically overlooked. Among several efforts underway, she teaches a course titled "Machine Learning with Small Data," designed to equip students with the skills to overcome data challenges that often exclude marginalized groups, contributing to a more equitable technological landscape.

Her lab organized the first "CV4Smalls" workshop, dedicated to computer vision with small data, with a focus on infants and endangered animals. Additionally, they are hosting a special issue on "Computer Vision with Small Data: A Focus on Humans and Animals" in the international journal *Multimedia Tools and Applications.*

Ostadabbas also founded AiWover, a company that is addressing a critical gap in infant monitoring by offering an advanced AI-driven solution that overcomes the limitations of current baby monitors. There is an urgency to Ostadabbas's work—infant mortality rates are rising, with significant disparities linked to race and location. AiWover will not only save lives but will also help bridge the gap in healthcare quality that disproportionately affects marginalized communities

AiWover utilizes AI and advanced computer vision to track a baby's every movement, alert parents to potential dangers, and monitor developmental milestones. The system, which is cloud-based and contactless, supports parents and caregivers in ensuring their baby's safety and development.

Ostadabbas's work with computer vision in small data domains has reinforced the importance of inclusivity and special attention to underrepresented populations. As the director of the Women in Engineering (WIE) program, she is dedicated to nurturing a deep sense of belonging and self-confidence among women and all underrepresented student groups across the global university network.

The core objective of this initiative is to enhance the professional competencies of these students by improving both their technical and soft skills. This initiative aligns with her broader commitment to accessibility and equity in all aspects of her work. △

The Institute for Nanosystems Innovation: Advancing Semiconductor Research and Education in Oakland

The **Institute for Nanosystems Innovation** (NanoSI) at Northeastern University is a global institute dedicated to advancing semiconductor research, education, and entrepreneurship. With locations on both the Boston and Oakland campuses, NanoSI fosters collaboration between academia, industry, and government to drive innovation in the semiconductor field.

The Oakland campus, nestled in the Oakland hills, provides proximity and collaboration opportunities with Silicon Valley industry leaders, U.S. National Labs, and other universities. An MOU with UC Berkeley allows access to the Marvell Nanolab cleanroom facility, further enhancing research capabilities.

NanoSI Oakland faculty members include:

- **David Horsley**, professor of electrical and computer engineering, experienced semiconductor startup entrepreneur, and expert in MEMS and microfabricated sensors.
- **Yuan Yuan**, senior research scientist at Hewlett Packard Labs with expertise in optoelectronic devices, silicon photonics, and large-scale photonic integrated circuits.
- **Aravind Nagulu**, assistant professor of electrical and systems engineering at Washington University in St. Louis, specializing in integrated circuits, electromagnetics, and communication systems.

NanoSI Oakland is committed to educating the next generation of semiconductor professionals through various academic programs, including two that will be introduced in the spring of 2025, the PhD EE program and the ECE Semester in Oakland. An MS in semiconductor engineering will begin in the fall of 2026.

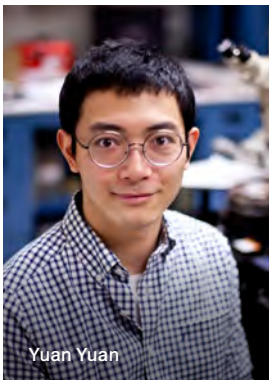
The Northeastern University Semiconductor Workforce Partnership Alliance Program includes collaborations with industry leaders such as Onto Innovation, Raytheon, ASMPT, MACOM, and Teradyne. These partnerships provide students with real-world experience and career opportunities.

NanoSI actively promotes entrepreneurship and innovation through workshops and international partnerships. The US-Taiwan Workshop on DeepTech Innovation & Partnerships fostered collaboration between startups, accelerators, and investors in the semiconductor and related fields.

NanoSI Oakland is a hub for semiconductor research, education, and entrepreneurship. With its strong faculty expertise, cutting-edge facilities, and industry partnerships, NanoSI is well-positioned to address the global challenges and opportunities in the semiconductor field. △

The Institute for Nanosystems Innovation on the Oakland campus. *Photo by Greer Rivera*


David Horsley


Yuan Yuan


Aravind Nagulu

Northeastern University
Oakland

ECE in the Global University System

The Electrical and Computer Engineering (ECE) department is providing faculty and students opportunities throughout the Northeastern global network with comprehensive co-op and academic programs, mobility experiences, and hybrid teaching methods that span multiple campuses.

Northeastern University's Global University System is a dynamic, interconnected system of campuses, research hubs, and partnerships that span across the United States, Canada, and the United Kingdom. The global campuses each offer unique academic programs and access to regional industries.

The network fosters experiential learning by connecting students with global co-op opportunities, internships, and research projects, allowing them to gain hands-on experience in diverse cultural and professional settings. This approach emphasizes flexibility, interdisciplinary collaboration, and a commitment to lifelong learning, empowering graduates to thrive in an increasingly interconnected world.

ECE Programs in Seattle and Oakland

The first graduate program at Northeastern's Seattle campus launched in Fall 2023, offering two concentrations of the MS in electrical and computer engineering to a cohort of 14 students. These students attended courses at the South Lake Union location. Enrollment has since tripled. A new program, an ECE concentration within the MS in robotics, is set to begin at the Seattle campus in Fall 2025. A full-time teaching faculty member, ECE Associate Teaching Professor **Joe Weber**, along with part-time lecturers, currently support teaching efforts at this campus. Additional teaching faculty will join the Seattle location in the Fall of 2025 to accommodate the growing programs.

The ECE department plans to offer a wide range of programs at the Northeastern Oakland campus, from undergraduate mobility experiences to PhD degrees. The "Semester in Oakland" program, allows undergraduate students from Boston to take courses while working at the cutting edge of semiconductor technologies, wireless sensor networks, and AI tracking. This program emphasizes hands-on learning, integrating co-op opportunities with direct access to industry leaders. Furthermore, the expansion of the electrical and computer engineering major, as well as the combined computer engineering/computer science major, is under consideration for this location.

Graduate programs will include an MS in semiconductor engineering, scheduled to launch in Fall 2026. This program will offer courses and research experiences led by the faculty of the Institute for NanoSystems Innovation (featured on page 10). The PhD in electrical engineering program will begin in Spring 2025, with students able to work under the supervision of Oakland-based faculty, including ECE Professor **David Horsley**, and beginning in the Spring 2025 semester, ECE Assistant Professors **Aravind Nagulu** and **Yuan Yuan**.

Faculty Presence in the Global Network

The ECE department is actively considering expanding faculty positions across multiple campuses in the global network to support the growth of educational programs and enhance research opportunities. In addition to Oakland and Seattle faculty positions, the ECE department has a strong presence at the Northeastern University Innovation Campus in Burlington and it is pursuing opportunities to create a wireless networking research cluster at the London campus.

The Makerspace Classroom at Northeastern's Oakland campus. *Photo by Ruby Wallau*

Interdisciplinary Research Sabbaticals

Tenured faculty eligible for sabbatical leave can choose to spend one semester of their sabbatical in another academic unit, with the goal of fostering interdisciplinary research collaborations. Northeastern strongly encourages faculty to engage with academic units at different campuses within the global network. As examples, ECE professors **Stefano Basagni** and **David Kaeli** are on sabbatical at the Oakland campus and the Roux Institute in Portland, Maine, respectively,

Teaching at Another Campus/Visiting While Teaching Remotely

All faculty members have the option to teach a course at a different campus. For those who teach via "live cast," which involves live streaming from one campus to students located at another campus, they are encouraged to spend at least a week at the remote campus. This visit provides the opportunity to teach in person and engage directly with the students at the remote location. △

Stefano Basagni
ECE Director of Global Programs

Photo by Adam Glanzman

Joseph Weber

David Kaeli

Research Areas of Interest in My Laboratory

Cristian Cassella, Associate Professor

We are witnessing a technological revolution driving progress across most segments of science and engineering. The expansion of the Internet of Things (IoT), the development of more powerful wireless communication systems, the growth of artificial intelligence (AI), and its widespread availability are profoundly transforming how we communicate, monitor people's health, verify buildings' integrity, learn, teach, research, navigate, and much more.

A noteworthy example of this transformation is the evolution of wireless communication. I vividly recall that just six years ago, at the beginning of my academic career as an assistant professor, the transition from fourth- to fifth-generation wireless communication was hailed as a potential revolution. However, the excitement surrounding 5G was often tempered by a sense that we were not "technologically" prepared for it. Instead, the combined efforts of numerous scientific communities have made 5G a reality, and researchers are now preparing for the sixth-generation wireless technology. This raises the question, "How did we make it work?" Well, this was possible by recognizing the necessity of coordinated innovation at all levels, including science, materials, devices, and systems. This awareness will continue to be fundamental as we tackle future scientific challenges.

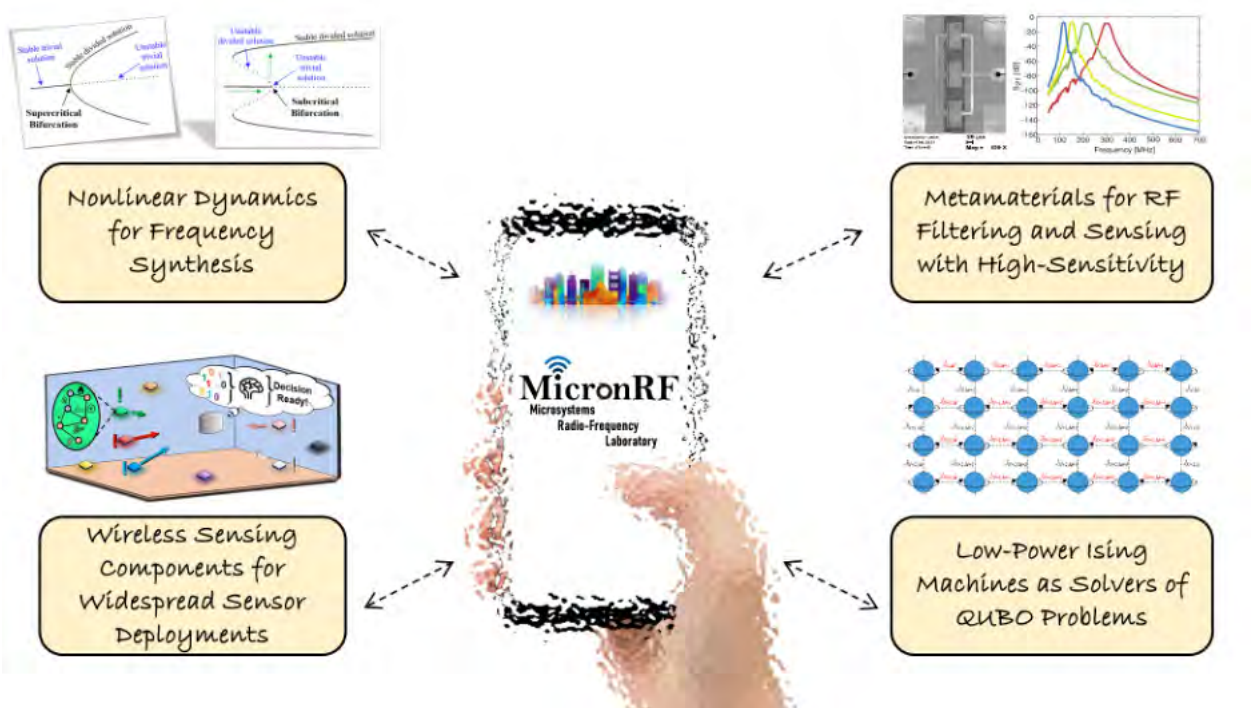
Throughout my academic career, my research has covered diverse areas in physics and engineering, with a consistent focus on developing technological enablers and improving technology accessibility to ensure that the entire global population benefits from scientific progress. For instance, to meet the needs of emerging IoT applications, my research group, the MicronRF laboratory, with the support of the National Science Foundation, has been searching for new wireless sensing technologies that can be manufactured sustainably and have minimal impact on the environment. In this effort, we have sought to redefine what is feasible with passive wireless sensors, which have historically been regarded as mere electromagnetic scatterers that are incapable of performing any meaningful signal processing operation.

By simultaneously leveraging electromagnetic passives and chip-scale piezoelectric microacoustic devices built in-house, we have demonstrated that passive wireless sensors can be much more than simple electromagnetic scatterers. In fact, my group has developed several passive wireless sensor nodes. One led to a patent and another five are pending patent applications.

Such wireless sensor nodes are capable of detecting and memorizing violations in sensing parameters from tens of meters away or localizing flying unmanned vehicles with 1% ranging accuracy. Recently, we have successfully demonstrated that passive wireless sensor nodes can be used to solve optimization problems based on a pool of parameters that are locally sensed in real time. This capability is essential for upgrading buildings with strategic decision-making abilities that enhance energy efficiency and reduce emissions—a critical objective in the global fight against climate change. These facilities could include data centers, power plants, underground facilities, and farms.

With the support of the Defense Advanced Research Projects Agency (DARPA) Tunable Ferroelectric Nitrides (TUFEN) and Wideband Adaptive RF Protection (WARP) programs, my group has also been working to extend the wireless communication capabilities of current radios beyond the limits imposed by the available materials. To achieve this, we have explored the intriguing dynamics of photonic metamaterials and applied them to the fields of piezoelectricity and elasticity. This effort has so far led to two patents and four patent applications.

It has enabled chip-scale filtering devices with bandwidth exceeding the maximum achieved by the current counterparts, while still being manufacturable through fabrication processes commonly used in consumer electronics. Recognizing that radios equipped with wider band filters are more vulnerable to losses in integrity and performance due to electromagnetic interference, we have also pursued methods to transform radio front-ends into systems that instinctively adapt to suppress any received electromagnetic interference, in collaboration with ECE Professors **Marvin Onabajo** and **Mariam Leeser** and their research teams.



Finally, in collaboration with the teams of ECE Professor and Interim Department Chair **Josep Jornet** and ECE Assistant Professor **Benyamin Davaji**, my group has begun exploring enabling technologies for 6G, with a specific focus on the design of programmable antennas that can enable the current system-level vision of THz communication. The group is investigating the use of nanoscale ferroelectric materials heterogeneously integrated into on-chip electromagnetic antennas. This exploration aims to create reprogrammable reflectors capable of dynamically steering THz electromagnetic signals, ensuring that communication capabilities are not disrupted by static or moving objects.

Addressing challenges in the wireless space is not the only focus of my research group. Another significant challenge we are tackling, with the support of the NSF, is identifying approaches to effectively resolve large-scale quadratic unconstrained binary optimization problems. For decades, both academia and industry have relied on deterministic algorithms and general-purpose von Neumann computing architectures to solve QUBO problems. However, as Moore's law continues to slow down, the current computing paradigm is reaching its limits in handling the growing complexity of QUBO problems, making it increasingly inadequate to address emerging questions across various disciplines, including genetics, physics, finance, and medicine. In response, multiple communities are exploring alternative brain-inspired computing paradigms, with a special focus on Ising machines–new computational engines capable of solving combinatorial optimization problems in the classical or quantum domain.

Until recently, a major limitation of all the existing Ising machines was their significant power consumption. Powers reaching the kilowatt range were needed to solve problems of interest with thousands of variables. Fortunately, my group has recently developed a new Ising machine that enables power consumption below one watt when solving QUBO problems with a million variables. This effort has effectively created a path toward solvers that can be accessed by everybody to solve even the most complex scientific and societal QUBO problems of our time.

Finally, thanks to the support of DARPA QUAntum Materials Engineering using eLEctrOmagNetic fields (QUAMELEON), we are currently engaged in replicating exotic phenomena typically occurring at the atomic level in topological physics with chip-scale piezoelectric actuators. This pursuit aims to identify methodologies that can leverage the strong wave-matter interactions of topological systems in practical environmental and biological applications to enhance the sensitivity of the best currently available sensors and enable important scientific breakthroughs in astronomy, biology, quantum computing, and medicine. Similarly, under the DARPA OPTIM program, my group is exploring nonlinearities in circuits for frequency generation, a critical priority for enhancing national security and for achieving sensors' read-out not limited by noise affecting the read-out circuitry.

Student Successes

SELECTED HIGHLIGHTS

Series of PhD Research Awards

Duschia Bodet, PhD'25, electrical engineering, and triple Husky, won the Best Paper Award out of 3,200 submissions, as well as placed first in the 4-Minute Thesis competition at the IEEE Global Communications Conference (Globecom) 2023. She also received the Outstanding PhD Student Award in Research from Northeastern University. Most recently, she received the prestigious Paul Baran Young Scholar Award from the Marconi Society. At the award ceremony, which took place in Bologna, Italy, Duschia had the opportunity to meet with distinguished personalities that have shaped the telecommunication industry, from the inventor of the cellphone to the Alamouti codes in MIMO or distributed WIFI networks, including Marty Cooper, Siavash Alamouti, Andrea Goldsmith, Teresa Meng, Hari Balakrishnan, and Sir David N. Payne. This award recognizes young scientists and engineers whose work in information and communications technology will help connect the next billion people. Duschia's work, supervised by Professor **Josep Miquel Jornet** at the Institute for the Wireless Internet of Things, focuses on the design of wireless communications networks in the terahertz band, an uncharted frequency range in the electromagnetic spectrum.

2024 Amazon Robotics Day One Fellowship

Sophia Jonas, MS'26, robotics, is one of seven new fellows selected for the 2024 Amazon Robotics Day One Fellowship, which supports students from underrepresented backgrounds in STEM fields pursuing robotics degrees. She is pursuing work in human-robot interaction and augmentation, such as exoskeletons, or terrain-based search-and-rescue robots.

ACM/IEEE CS George Michael Memorial HPC Fellowship

Rohan Basu Roy, PhD'24, computer engineering, was awarded the prestigious Association for Computing Machinery/IEEE Computer Society George Michael Memorial High Performance Computing Fellowship for enhancing the productivity of computational scientists and environmental sustainability of high-performance computing with novel methods and tools exploiting cloud computing and on-premise HPC resources. Basu Roy is advised by **Devesh Tiwari**, associate professor of electrical and computer engineering.

National Defense Science and Engineering Graduate Research Fellowships

Andrew Ashdown, PhD'27, electrical engineering, and **Connor McLaughlin**, PhD'27, computer engineering, were recipients of the 2024 Department of Defense National Defense Science and Engineering Graduate Research Fellowship. Highly competitive, it is awarded to promising U.S. scientists and engineers to encourage them to pursue doctoral degrees in designated research disciplines of military importance.

Andrew Ashdown
PhD'27

Connor McLaughlin
PhD'27

Mars Rover Team Places First at International Rover Challenge

The **Northeastern Mars Rover team** competed in the inaugural Winter Canadian International Rover Challenge, where they took home the gold, placing first and securing their first-ever competition win. Northeastern competed against teams from McMaster University, the University of Toronto, and York University.

Best Student Paper Finalist Award at IFAC SYSID 2024

Mohammad Alali, PhD'25, electrical engineering, received the Best Student Paper Finalist Award from the 20th IFAC Symposium on System Identification (SYSID 2024) for his paper "Kernel-Based Particle Filtering for Scalable Inference in Partially Observed Boolean Dynamical Systems."

Patent for Improving RF Resonator Technology

Cristian Casella, associate professor of electrical and computer engineering, and **Xuanyi Zhao**, PhD'23, electrical engineering, who is pictured on the left, were awarded a patent for "Two Dimensional Rod Resonator for RF Filtering."

FLEX 2024 Innovators of the Future Student Poster Award

Yilmaz Arin Manav, PhD'28, electrical engineering, won first place at the Innovators of the Future Student Poster Award session at FLEX 2024 (SEMICON West) for his research on "Flexible Hybrid Electronics Metrology Enabled by GHz Ultrasound." He is advised by **Benyamin Davaji**, assistant professor of electrical and computer engineering.

NASA Postdoctoral Fellowship

Ali Al Qaraghuli, PhD'24, electrical engineering, received the highly competitive NASA Postdoctoral Fellowship and is now a postdoctoral research fellow at the NASA Jet Propulsion Laboratory.

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