NJIT
New Jersey Institute of Technology

2021 RESEARCH INSTITUTES, CENTERS AND LABORATORIES SHOWCASE

TUESDAY
MARCH 30, 2021


Microfabrication Innovation Center

Scholarly research is at the very center of university academic life at NJIT. It is integrated into everything we do, from the recruitment of new faculty and the creation of interdisciplinary innovation hubs, to the proliferation of research opportunities for our graduate and undergraduate students, to events such as today's Institutes, Centers and Laboratories Showcase, which is designed to foster collaborations that lead to groundbreaking new ideas and inventions that will advance society.

Our strategic plan, *Building on a Strong Foundation – NJIT 2025*, calls on the university to play a leading role in five emerging areas of multidisciplinary research – Bioscience and Bioengineering, Data Science and Management, the Environment and Sustainability, Material Science and Engineering, and Robotics and Machine Intelligence – as we address the grand challenges of society. They include, among others, building sustainability into all facets of modern life, improving the health of our planet and its people, and discovering new means to gather and harness data to tackle these and other problems.

NJIT's accomplishments under our previous five-year plan, *2020 Vision*, put us in a strong position to make substantial contributions going forward. Externally funded research grew from $63 million in 2014 to $106 million in 2019. Total research expenditures increased over the same period, from $106 million to over $161 million. The number of doctoral students grew by 37%, from 381 in 2014 to 522 in 2019. The number of research institutes, centers, and laboratories, the primary vehicles for tackling multifaceted societal problems, has increased from 31 in 2010 to 135 today. The count of tenured and tenure-track faculty has surpassed 320, more than 50 percent of whom we hired in the last ten years. This growth, reflecting the synergy between NJIT's research enterprise and New Jersey Innovation Institute, its public/private business development corporation, moved NJIT onto the prestigious list of 131 national doctoral universities with the "Very High Research Activity" (R1) Carnegie Classification. NJIT now also ranks 74th in the U.S. according to the Quacquarelli Symonds (QS) World University Ranking® USA 2020 list.

In 2014, we inaugurated a seed-grant program to support interdisciplinary projects between fields as diverse as architecture and biomedical engineering. The program took off, and is now integrated into other R&D organs on campus and through our partners, enabling us to promote these projects from their inception, to translation, to acceleration, as faculty and student researchers and entrepreneurs pursue preliminary market research, validation and pre-commercialization of their ideas and inventions.

With our ongoing $500 million capital-building program, we continue to transform research and education on campus. Our newest facility, the Microfabrication Innovation Center, houses advanced equipment and a cleanroom environment for the fabrication of micro- and nanoelectronic and microfluidic devices and sensors. The Makerspace at NJIT, a now 21,000-square-foot training-focused, rapid prototyping facility, provides the university's education and research community with the latest design and fabrication equipment.

For those who are new to the community, you are most welcome. We hope the research showcase opens up intriguing new vistas for you. Dive in!

Fadi-Pierre Deek

Fadi P. Deek
Provost and Senior Executive Vice President


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Welcome to the 2021 Research Institutes, Centers and Laboratories Showcase, an annual celebration of NJIT's most potent and promising engines of innovation. The approximately 135 institutes, centers and labs represented today reflect the steady, strategic growth in the university's research enterprise. Over the past five years, more than 85 of these hubs have been created, while total external research and development awards have increased by more than 120% and expenditures have nearly doubled.

We come together today, however, because these nodes of expertise do not exist in isolation. NJIT strongly believes that as researchers, we are most innovative and productive when we join together across disciplines to solve complex challenges that defy simple answers and niche know-how. Our research clusters encompass Bioscience and Bioengineering, the Environment and Sustainability, Material Science and Engineering, Robotics and Machine Intelligence and Data Science and Management. These clusters invite multidisciplinary collaborations on campus, at peer institutions and with partners in industry, government and business that advance innovations in research that are effectively translated into high-impact, real-world applications.

Our four research institutes – the Institute of Brain and Neuroscience Research, the Institute of Space Weather Sciences, the Leir Institute for Business, Technology and Society and the Institute of Data Sciences – take up system-wide challenges in their sectors. State-of-the art equipment at the York Center for Environmental Sciences, the Life Sciences and Engineering Center and, most recently, the renovated Microfabrication Innovation Center, a state-of-the-art nanoelectronics fabrication facility with the highest-level cleanroom, allow us to characterize and process novel materials and to fabricate devices and sensors for a broad spectrum of environmental, energy, water remediation and medical applications.

We continue to focus on three grand challenges inspired by "big ideas" in science and technology identified by federal agencies such as the National Science Foundation, the National Institutes of Health, the U.S. Department of Defense and other major organizations and foundations, including the World Health Organization, the Gates Foundation and the United Nations Foundation's sustainable development goals.

Within the **health care** arena, we focus on physiology-based innovations that include wearable health-monitoring technologies; cellular and tissue engineering-based therapeutic technologies; traumatic brain injury, brain health and improvements to neurological functions; human-robotic assistive devices; women's health; smart drug delivery systems; and smart healthcare information management systems.

Our diverse approaches to **sustainability** include system optimizations across sectors, technologies to protect and clean the environment and the development of next-generation infrastructure that is durable and green. Our devices and processes include novel energy materials and delivery systems; water treatment and waste management; environment and climate resilience; new knowledge of space weather; intelligent adaptive transportation; smart buildings and cities; and additive manufacturing.

Our third major emphasis is on **high-performance computing, artificial intelligence and cyber-infrastructure technologies**, including system architectures for complex high-performance data analytics; cybersecurity and secured adaptive networking; co-evolution and augmentation of machine and human intelligence; smart robotics in technological and societal applications, such as assisted living; and robust data management.

Atam P. Dhawan
Senior Vice Provost for Research

Research is an integral part of a strong academic experience and a critical priority in NJIT's strategic planning. The university aims for national and international prominence in research through new discoveries in areas ranging from medical sensors and devices, to robotics, to nanotechnology, to cybersecurity, to next-generation materials, among other topics of vital importance in basic, applied and translational research.

The 150 new faculty members we have hired over the past five years strengthen our efforts considerably. They include experts on topics such as biomedical sciences and engineering, sensors, energy, novel materials, machine learning, data analytics and virtual reality. They arrive with impressive track records in securing grants from key funding agencies such as the National Science Foundation, the National Institutes of Health, the U.S. Department of Energy and the U.S. Department of Defense.

To achieve our research and educational goals, the university's strategic plan calls for seamless multidisciplinary research collaborations and technology innovation-based entrepreneurship among faculty, staff and students, all of whom have a central part to play in advancing science, engineering and technology to fuel societal progress. We have organized our research into five principal areas.

BIOSCIENCE AND BIOENGINEERING

This research cluster includes research in the areas of biomedical devices, sensors and instrumentation, brain health and neuroscience, tissue engineering, biological sciences and behavior, molecular biology, evolutionary sciences, and gene therapy and phenotype related research. Researchers at NJIT are advancing our understanding of the functions of the brain and spinal cord under normal, injured and diseased states at molecular, cellular and functional levels through experimental, theoretical and computational methods. Imaging experts, computer scientists and biomedical engineers are working together, for example, to devise therapies and devices that will improve motor, cognitive and organ functions. To this end, our tissue engineers focus on replacing dysfunctional cells with regenerated cells and tissues. The Bioscience and Bioengineering cluster intersects with other research clusters to develop healthcare technologies and systems such as point-of-care medical sensors, devices and rehabilitation systems, as well as healthcare information systems and management involving primary care, hospitals and emergency care resources and protocols.

The scope of the proposed cluster includes areas that are aligned with the NSF's 10 Big Ideas, and the National Academy of Engineering (NAE) and the National Academy of Sciences (NAS) Grand Challenges in "Reverse Engineering of the Brain," "Tools for Scientific Discovery," "Understanding the Rules of Life: Predicting Phenotype" and "Engineering Better Medicine."

DATA SCIENCE AND MANAGEMENT

This research cluster includes the study and practice of data science and analytics and the extraction of information and knowledge from data that can be used for medical, financial, business management, scientific and engineering applications. These groups conduct research on bioinformatics, medical informatics, image processing, data mining, solar-terrestrial physics, transportation, financial management, business administration and management, life sciences and healthcare.

The cybersecurity group designs secure cyber systems and improves cyber information and communications technology (ICT). ICT is shaping many aspects of society as the economy evolves rapidly, providing access to unprecedented amounts of information, anytime and anywhere, from any type of device. By 2025, the number of global IoT (Internet of Things) connections will increase to more than 30 billion from 12 billion in 2020, according to an estimate by IoT Analytics. Global spending on security hardware, software and services is estimated to reach about $175 billion by 2024, according to Statista.

The Data Science and Management cluster, with its broad transdisciplinary scope, also includes research centers focused on mathematical sciences, transportation systems, additive manufacturing, wireless communications technology and industry and business management, as well as a focus on the societal impacts of science and technology. Working across disciplines, its researchers develop data-driven approaches in applications ranging from healthcare information systems, to industry automation, to finance and business management.

NAE and NAS Grand Challenges and NSF Big Ideas within the scope of this cluster include "Securing Cyberspace," "Advancing Personalized Learning", "Enhance Virtual Reality" "Restore and Improve Urban Infrastructure", "Engineering the Tools of Scientific Discovery," "The Future of Work at the Human-Technology Frontier," "Harnessing the Data Revolution," "Growing Convergence Research" and "The Quantum Leap: Leading the Next Quantum Revolution."

ENVIRONMENT AND SUSTAINABILITY

This cluster represents research in urban ecology, solar physics and space weather, environmental sensors, sustainable infrastructure, intelligent transportation systems, global climate change, biodiversity and conservation, clean water, waste management, renewable energy, smart grid systems, and additive/advanced manufacturing systems. The urban ecology and sustainability area emphasizes sustainable infrastructure, smart transportation, ecological communities and urban modeling and simulation. We study the connection between space weather and evolutionary changes in the solar system for direct impacts on our ecosystems and climate changes globally. This area also focuses on the water-energy nexus and the impact of ocean levels on the environment, as well as the development of technologies to clean water and to provide green energy, such as biofuel cells and powerful, long-lasting batteries. Research in the manufacturing systems group involves new methods and technologies in design innovation and process automation. A specific emphasis is the creation of new processes and tools for pharmaceutical manufacturing. The Environment and Sustainability cluster intersects with other clusters to develop smart and green buildings and sustainable communities, to understand space weather and climate changes, and to devise intelligent adaptative and data-driven automations in additive manufacturing systems.

NAE and NAS Grand Challenges and NSF Big Ideas within the scope of this cluster include "Solar Energy," "Restore and Improve Urban Infrastructure," "Access to Clean Water," "Energy from Fusion," "Carbon Sequestration Methods", and "The Future of Work at the Human-Technology Frontier," "Navigating the New Arctic" and "Windows on the Universe."

MATERIAL SCIENCE AND ENGINEERING

This cluster represents research in advanced materials, including smart energetic and **composite** materials, quantum materials, biomaterials, polymers, membrane technologies and nanotechnologies. The scope of nanotechnology research includes scientific and engineering phenomena at the minutest and most fundamental levels in order to develop technologies for environmental and pharmaceutical applications. The interdisciplinary group focused on engineered materials and particulates develops technologies to prepare, process and use engineered-particulate materials and their composites for a spectrum of applications.

The Material Science and Engineering group works on environmental and medical sensors and devices, tissue engineering, intelligent robotics and rehabilitation systems, additive and pharmaceutical manufacturing, smart buildings and sustainable communities, as well as data-driven modeling and simulation for the development and characterization of smart materials.

NAE and NAS Grand Challenges and NSF Big Ideas within the scope of this cluster include "Restore and Improve Urban Infrastructure," "Solar Energy," "Energy from Fusion" "Carbon Sequestration Methods," "the Future of Work at the Human-Technology Frontier," and "The Quantum Leap: Leading the Next Quantum Revolution."

ROBOTICS AND MACHINE INTELLIGENCE This research cluster includes the human-machine interface, cyber-human systems, robotics, including bioinspired, medical, social and industrial autonomous systems, intelligent infrastructure, artificial intelligence, machine learning and augmented and virtual reality. Robotics and bioinspired autonomous systems are making a significant impact in areas such as rehabilitation, manufacturing, navigation and transportation and medical and home-based care. The artificial intelligence and augmented/virtual reality applications have evolved rapidly, bringing new modes of automation, social networking and the co-evolution of machine and human intelligence to make important decisions in our daily life from finance to healthcare.

The Robotics and Machine Intelligence cluster also develops smart automation and navigation systems, smart healthcare information systems and intelligent systems for applications in education and learning, to smart cities, to and living-assistance systems.

NAE and NAS Grand Challenges and NSF Big Ideas within the scope of this cluster include "Advancing Personalized Learning," "Enhancing Virtual Reality," "Restoring and Improving Urban Infrastructure," "Engineering the Tools of Scientific Discovery," "The Future of Work at the Human-Technology Frontier," "Harnessing the Data Revolution," "Growing Convergence Research" and "The Quantum Leap: Leading the Next Quantum Revolution."


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BIOSCIENCE AND BIOENGINEERING

Institute for Brain and Neuroscience Research

Farzan Nadim and Namas Chandra, Co-Directors

The Institute for Brain and Neuroscience Research (IBNR) takes a multipronged approach toward understanding neural circuits and their disruption. IBNR neurobiologists examine the simple nervous systems of animals such as crustaceans and worms, while mathematicians develop models of neuronal patterns. IBNR biochemists conduct laboratory analyses of the biochemical building blocks of internal mechanisms such as the circadian clock. The Institute is equally committed to mitigating the effects of disabling neurological disorders and injuries by designing devices and therapies that help people function to their full potential. In these efforts, neurorehabilitation and biomechanics engineers work closely with imaging experts who have devised ways to map the brains of people affected by diseases such as Alzheimer's and developmental conditions such as ADHD and dyslexia, as well as changes in brain patterns in response to visual and hearing disorder treatments that our researchers develop. IBNR researchers work closely with clinicians in the region and throughout the country on a variety of therapies. Our biomedical engineers partner with the Kessler Institute and hospital-based rehabilitation centers to develop exoskeletons and other devices that will help people with neurological disorders participate in classrooms and in workplaces; our traumatic brain injury specialists collaborate with New Jersey-based physicians and medical researchers on their work for the U.S. Department of Defense and with clinicians and researchers at pediatric hospitals from Pennsylvania, to Alabama, to California.

BioSensor Materials for Advanced Research & Technology Center

Omowunmi Sadik, Director

The mission of the BioSensor Materials for Advanced Research & Technology (BioSMART) Center is to understand how biological systems communicate with their surroundings by gathering data with sensors on their internal states and environments, measuring the information, and then using that knowledge to develop innovative sensing technologies that employ sustainable materials and greener environmental processes. BioSMART seeks to meet society's need for fully autonomous, self-aware and resilient intelligent chemical and biological sensor systems by learning – and designing – from nature. Biological systems, without exception, are SMART sensors. Their behavior is the result of a complex web of interactions between sensory inputs and physiological processes that implements cognitive functions to allow the organism to perform efficiently. The BioSMART team has developed innovative biosensors for ultrasensitive detection of Staphylococci Enterotoxin B, the microorganisms that compose biofilms, nucleic acid mutations, E. coli, Bacillus globigii and numerous environmental pollutants: chromium VI; lead; polychlorinated biphenyls; microcystins; organophosphates; nitrobenzenes; and endocrine disrupting chemicals. One of our technologies has been translated to a portable, fully autonomous, remotely operated sensing device known as an Ultra-Sensitive Portable Capillary Sensor, or U-PAC. Some of our earlier sensors have been used for the detection of trace uranium and vanadium. Current projects include environmental sensors for COVID-19, pain biosensors, sustainable nanomaterials, biodegradable polymers, and new diagnostic tools and detection devices for medical, environmental and military applications. The wide range of intelligent sensor systems that can become commercial realities through advances pioneered by BioSMART will benefit society in antibiotic resistance monitoring, environmental analysis, wireless sensor networks, robotic sensors, bioremediation and point-of-use 'smart' systems.

Center for Brain Imaging

Bharat Biswal, Director

The long-term goal of the Center for Brain Imaging is to better understand human brain functioning using integrative neuroimaging and statistical and computational modeling methods. We believe it is essential to understand the complexity of brain function and its development in order to develop effective treatments. We have four research themes: human brain functional patterns and their development; reliable neuroimaging measures; functional patterns in animal models; the links between specific psychological processes and brain function and the means by which mental and neurodegenerative diseases disrupt brain function. We use modern neuroimaging techniques (MRI, fMRI, PET, fNRIS) to map the three levels of intrinsic functional brain architecture – regions; subnetworks; and the entire brain. We then direct our investigations to brain development within different stages of life, to computational simulation of the brain's neural connections and to clinical psychology and psychiatry guided by our neuroimaging results. We are working on several disease models, including Alzheimer's, schizophrenia and autism, as well as on the effects of aging and spinal cord injury. Our research is currently funded by the National Institute on Aging and the National Institute of Biomedical Imaging and Bioengineering, the National Science Foundation, the New Jersey Commission on Spinal Cord Research and the N.J. Governor's Council for Medical Research and Treatment of Autism.

Center for Injury Biomechanics, Materials and Medicine

Namas Chandra, Director

The Center for Injury Biomechanics, Materials and Medicine (CIBM3) is a multi- and interdisciplinary research center focused on understanding, diagnosing and treating brain injuries and concussions using experimental and computational methods. The CIBM3 is involved in both traumatic brain injury (TBI), a major concern among U.S. soldiers and veterans, and mild TBI and concussion in sports injuries, which also raise serious health concerns. Specifically, through novel blast-tube and drop-tower facilities, we examine what type of helmets, pads and configurations offer the right protection for soldiers and players. We study when and how concussions are caused and if there are simple diagnostic methods to identify concussions. We use animal models and mechanical surrogates to examine the role of blast pressures and the height of falls to relate injury to medical outcomes. Some of our recently funded efforts include examining the effect of blast overpressures on the dose-response curve of animal models and research into the mechanisms of blast-induced brain injury. In yet another project, we use experimental methods to study the effect of eyewear and hearing protection on the TBI susceptibility of warfighters. Namas Chandra, Bryan Pfister and James Haorah, along with other colleagues from NJIT, medical schools and Veterans Administration facilities take a holistic approach to offer new measurement techniques, diagnostics and prognostic tools to address sports injuries and military medicine.

Advanced Biomaterials Translation Laboratory

Vivek Kumar, Director

The Advanced Biomaterials Translation Laboratory develops novel peptide-based hydrogels that are injected and then self-reassemble in situ in tissue spaces. These constructs can be designed to deliver drugs and other small cargo over day, week or month-long periods. Facile modification of the base peptide allows for the development of novel drugs that can specifically target angiogenesis, neurogenesis, osteogenesis and even the delivery of antigenic sequences for vaccine development. Motivated by translational goals, the lab engages in academic science, biopharmaceutical development, medical device prototyping, drug design and delivery and entrepreneurship. Our current work has led to the establishment of platforms for the treatment of maladaptive angiogenesis, ischemic tissue disease, diabetic ulcer wound healing and dental pulp regeneration, among other therapies.

BioDynamics Laboratory

Xianlian Alex Zhou, Director

The BioDynamics Laboratory focuses on computational biomechanics and bioengineering, robotics and human-robot interaction, injury prevention and personalized medicine. The lab aims to develop advanced computational methods and software to simulate and understand the dynamics and neuromuscular control of human locomotion; to analyze biomechanical loadings in different biosystems (such as musculoskeletal, vascular, and respiratory systems) under normal, extreme or injurious conditions. We also design and evaluate wearable assistive devices such as exoskeletons for human performance augmentation or rehabilitation and to develop protective or preventive measures and treatment options against injuries or diseases.

Cardiovascular Tissue Engineering and Stem Cell Laboratory

Eun Jung Lee, Director

The Cardiovascular Tissue Engineering and Stem Cell Laboratory focuses on understanding and developing therapeutic strategies to repair cardiovascular diseases. The lab develops various in vitro cardiovascular tissue models that involve integrated use of stem cells, biomaterials and biomimetic bioreactors. These tissue models are used to investigate the biophysical cues needed for heart and microvascular development. Moreover, diseased tissue models allow us to understand the mechanisms and the interaction between cells and their extracellular environment during pathological conditions, providing a novel means for evaluating new treatments for diseased or damaged cardiac tissue.

Circadian Clock Laboratory

Yong-Ick Kim, Director

The Circadian Clock Laboratory researches the detailed biomolecular mechanisms of the circadian clock, the bodily and behavioral changes tied to the 24-hour daily cycle that synchronize to daylight and darkness. Increasingly, these patterns are disrupted by modern urban culture, including the omnipresence of artificial light and frequent travel across time zones. To explore the biochemical mechanisms that underlie these daily rhythms, we study the reconstituted in vitro circadian clock from a cyanobacteria, Synecochoccus elongates. The bacteria's central oscillator is encoded by three genes, KaiA, KaiB, and KaiC, whose protein products function together to generate a 24-hour rhythm of KaiC phosphorylation. The 24-hour KaiC phosphorylation rhythm is generated by the timely association and dissociation of these three Kai proteins. The laboratory works with biophysicists and mathematical biologists to examine hypotheses about the circadian clock's molecular mechanisms. By exploring them at this level, we expect to obtain critical clues for the treatment of medical problems related to the clock's disruption, including sleep deprivation and jet lag.

Computational Neuroanatomy and Neuroinformatics Laboratory ???

Xiaobo Li, Director

The Computational Neuroanatomy and Neuroinformatics Laboratory aims to fill the gaps in the fields of neurobiology and neuroimaging, especially the need for systematically constructed models of quantitative neurobiological criteria that can aid in clinical diagnoses of cognitive deficits associated with severe brain disorders. The Lab focuses on the development and implementation of analytical and statistical models for providing quantitative biological criteria that help identify cognitive deficits by integrating high-dimensional, multi-modal magnetic resonance neuroimaging, clinical and behavioral data and refined imaging analysis and machine learning techniques.

Computational Orthopaedics and Rehabilitation Engineering Laboratory

Saikat Pal, Director

The Computational Orthopaedics and Rehabilitation Engineering (CORE) Laboratory works on decoding the complexities of human movement through experiments and computational methods. In our experiments, we study three-dimensional kinematics, kinetics and electromyography from muscles during movement. Experimental methods alone cannot decode all of the musculoskeletal system's complexities, however, so we also develop and validate computational models of human movement during daily activities. Our insights are used to understand the onset, progression and treatment of musculoskeletal disorders. Current projects include: understanding joint loads during rehabilitation for bone health after spinal cord injury; changes in neuromuscular control strategies with aging; movement patterns in children with cerebral palsy; and building assistive devices for children with cerebral palsy.

Coppélia Research Laboratory

Carlotta Mummolo, Director

In the Coppélia Research Laboratory, a diverse team of students and researchers studies the behavior and performance of motor skills in biological and robotic systems. Our research is at the intersection of biomechanics, robotics and dynamical systems, leading to translational projects in the field of human motor rehabilitation. We focus on the development of theories, algorithms and robotic prototypes to understand fundamental principles of motor skills such as balance, locomotion and manipulation. This will provide novel models of motor behavior, as well as means for evaluating motor performance, in populations affected by conditions that impair mobility, such as aging, Parkinson's disease and spinal cord injury, among others. Ultimately, the mission of the Coppélia Research Laboratory is to translate our multidisciplinary research effort into improved bio-engineering solutions to human motor assistance and rehabilitation.

Ecohydrology Lab

Xiaonan Tai, Director

Interdisciplinary research at the Ecohydrology Lab encompasses ecology, hydrology, geographic information science, remote sensing and computer science. We seek mechanistic understandings underlying the geospatial patterns of vegetation dynamics and how they might influence the future of ecosystems and water resources in the context of new and emerging environmental conditions. More specifically, the lab seeks to answer the following questions: What are the mechanisms underlying ecosystem response to anticipated warming and drought? How do biotic diversity and abiotic heterogeneity influence ecosystem resilience and resource sustainability in changing climates? How do we increase ecosystem resilience through effective management strategies? To explore these questions, we use advanced, mechanistic modeling, statistical analysis, in situ and remote sensing observations and parallel computation to synthesize various data sources and to advance knowledge.

Laboratory of Evolutionary Pattern and Process

Phillip Barden, Director

Work in the Laboratory of Evolutionary Pattern and Process is comparative in nature. We analyze phenotypic and genomic variation across multiple species and lineages to understand the evolutionary history of life and the mechanisms responsible for maintaining biodiversity. Part of this work is historical. We estimate the phylogenetic relationships of living and extinct organisms in a temporal context, quantify ecological change over time, and reconstruct patterns of biogeography and trait evolution. We also work to uncover broad trends in evolution by analyzing behavioral or morphological traits at the lineage or ecosystem level. Because they are ecologically impactful and phenotypically diverse, we primary use eusocial insects, especially ants, as model systems for asking core questions. Our approach is multidisciplinary and combines paleontology, imaging methodology such as micro CT-scanning and confocal microscopy, comparative genomics, and systematics. The lab is currently focused on identifying convergent trends in genome evolution related to advanced social behavior; quantifying links among phenotype, ecology, and extinction; and maximizing data collection from fossil amber.

Fluid Locomotion Laboratory

Brooke Flammang, Director

In the Fluid Locomotion Laboratory, we take a multidisciplinary approach, integrating comparative anatomy and physiology, biomechanics, fluid dynamics, and biologically-inspired robotic devices to investigate the ways in which organisms interact with their environment and drive the evolutionary selection of morphology and function. By combining these different areas, we are able to approach broad-impact ecological and evolutionary questions from an experimental perspective and directly test the effective relationship between an organism and its environment. We use both live animal and robotic models to investigate several ongoing research projects in our lab. One major initiative focuses on the functional morphology of the remora's adhesive apparatus with applications in defense, healthcare, and technologies and devices requiring long-term reversible attachment in wet conditions. Other projects include studying the swimming behaviors of sharks, reptiles, and robotic models to interpret the functional morphology of extinct ichthyosaurs, modeling the passive high-throughput flow dynamics of chondrichthyan egg cases, and investigating the adaptive morphology and comparative biomechanics of fishes that can walk on land.

Global Change and Urban Ecology Lab

Daniel Bunker, Director

The Global Change and Urban Ecology Lab at NJIT aims to understand how species, ecological communities and ecosystems respond to the forces of global change. These forces include changes in temperature, precipitation and seasonality driven by increasing atmospheric CO2, as well as increasing pollution, invasive species, habitat fragmentation and urbanization. We use a combination of field, laboratory and modelling experiments to understand and predict these responses to global change. An example of ongoing research includes understanding how cockroaches spread through urban areas and vector human disease pathogens. Here we are using high throughput DNA sequencing to build population and dispersal models of cockroaches, and to quantify the microbiome found on cockroaches. Another example of ongoing research is an effort to understand how plants evolve adaptations to urban environments. Here we are studying Shepherd's Purse (Capsella bursa-pastoris), a common weed in urban environments around the globe. Our approach uses field and lab experiments coupled with real-time RNA expression to quantify local adaptations to polluted soils.

The Horax BioDatanamics Lab

Horacio Rotstein, Director

The goal of the Horax BioDatanamics Lab is to understand how biological oscillatory networks generate patterns of activity, how these networks process information and perform computations, and how all of these activities depend on the dynamic properties of the participating nodes, the connectivity and the network topology. We use mathematical modeling, numerical simulations and dynamical systems tools, and we have a well-developed network of collaborations with experimental scientists carrying out research both in vitro and in vivo. We particularly focus on oscillatory networks of the nervous system, which play important roles in cognition and motor behavior in both health and disease. This research includes the investigation of the mechanisms of selection of frequencies, amplitudes and additional observable activity attributes, and the network response to external, often oscillatory, inputs (e.g., resonances) as the result of the interplay of nonlinearities, time scales and levels of neuronal organization, including cellular, synaptic, micro-, meso- and macrocircuit. This research extends to biological networks in the context of chemistry and systems biology, including biochemistry and genetics. Our efforts also include the investigation of the relationship between experimental and observable data to models in collaboration with statistical neuroscientists. These projects include the resolution of unidentifiability in models and data (multiple parameter sets producing identical or similar observable activity patterns) and the determination of correlation and causal rules in neuroscience data. Our group is strongly committed to teaching and mentoring and the dissemination of science with the goal of having a societal impact, in particular on the education of young scientists.

Keck Laboratory for Topological Materials

Camelia Prodan, Director

The Keck Laboratory for Topological Materials uses interdisciplinary research to investigate the existence of what are known as topological phonons in microtubules (MTs), a naturally occurring biological material. Our theoretical evidence suggests that topological phonons are integral to the function of MTs – a cytoskeletal component in all eukaryotic cells that is essential for many fundamental cellular processes, including cell division and movement. Inspired by the mechanical properties of the microtubules, we work on laying the theoretical and experimental foundation for a new class of engineered materials that exhibit the unique vibrational and thermal properties of topological phonon edgemodes. Such materials may find application in sound deadening and amplification, and the management of heat flow.

Neural Engineering for Speech and Hearing Laboratory

Antje Ihlefeld, Director

A challenging problem for people with hearing aids or cochlear implants is that their devices do not function well in situations with background sound for the majority of users. The inability to hear what is being said can greatly limit social interactions, reduce employment opportunities and, in severe cases, lead to depression. To remediate this problem, current clinical approaches focus on the health of the ears. However, decades of research suggest that the health of the auditory portions of the brain also contributes to symptoms of hearing loss. The Neural Engineering for Speech and Hearing Laboratory examines how the brain processes sound through behavioral, physiological and computational modeling experiments, both in humans and in a preclinical model of hearing loss. We aim to identify the behavioral and neuronal mechanisms for hearing disruption to advance our scientific understanding and to develop remediation strategies that will improve hearing aid and cochlear implant function.

Neural Prosthetics Laboratory

Mesut Sahin, Director

The primary research focus of the Neural Prosthetics Laboratory (NPL) is to develop novel and translational neural prosthetic approaches and implantable devices in order to restore function in people with neurological disabilities resulting from injuries to the central nervous system, as in spinal cord and brain injuries, and strokes. In parallel, we aim to increase our knowledge about the role of the spinal cord and the cerebellum in motor coordination and sensory-motor integration. One of our recent projects involves modulation of the cerebellar activity using focused ultrasound and low frequency sinusoidal currents (transcranial alternating current stimulation) in animal models as a potential treatment modality in disorders of the motor system. We are also developing novel electrode arrays for multi-channel recordings of cerebellar activity using carbon microwires in animals during behavioral tasks. In previous years, the lab has developed microdevices that are activated by a near-infrared light beams for wireless neural stimulation of the spinal cord where tethered electrodes cannot be implanted.

Laboratory of Neurobiology and Behavior

Eric Fortune, Director

Research in the Laboratory for Neurobiology and Behavior examines the interactions between sensory and motor systems that are used to generate and control animal behavior. Experiments in the lab focus on two main questions: how sensory representations of movement are encoded by sensory systems and translated into motor commands, and how pairs of animals integrate social cues in the control of cooperative behaviors. We use methodologies that encompass varying levels of biological organization, from the computational consequences of transmembrane molecules to the behavior of multispecies flocks. Our work includes field studies of natural behavior in Amazon basin habitats, highly controlled behavioral studies in the laboratory, and a variety of neurophysiological approaches to central nervous system neurons in animals, pharmacological studies and mathematical modeling.

Neuroecology of Unusual Animals Laboratory

Daphne Soares, Director

How do nervous systems evolve and adapt to extreme environments? Evolution through natural selection has shaped nervous systems to generate behaviors. However, there are very few opportunities to study neural-circuit evolution where the ancestral and derived forms, as well as the adaptive environment, are all known and accessible. The Neuroecology of Unusual Animals Laboratory studies the synthesis of neuroethological and ecological principles to understand the evolution of neural adaptation. In our research, we have a three-pronged approach that examines the evolution of circuitries, molecular mechanisms of behavior, and sensory novelty. This integrative approach links a detailed characterization of the environment with the anatomy and function of neural systems within a phylogenetic context.

Laboratory of Neuroethology of Locomotion

Gal Haspel, Director

The Laboratory of Neuroethology of Locomotion studies the neurobiology of locomotion: How do nervous systems generate coherent muscle activity to propel animals in their environment? In particular, we focus on the levels of neuronalcircuits coordination in the locomotion of the nematode, C. elegans. This 1-millimeter-long roundworm moves through its environment by counteracting muscle contractions activated by a nervous system, as do all other animals, while also using the same molecular and cellular mechanisms, such as neurotransmitters and neuromodulators. Moreover, it offers several advantages as a research model: its nervous system is compact and includes only 302 neurons; it is small and transparent and fits under a microscope; and it is the only animal whose genome and nervous system have been completely mapped. This allows us to use a combination of optical methods to record and control neuronal activity together with transgenic methods to direct these tools to their targets. We use focused laser light to precisely dissect neuronal processes to study the circuit response to injury and regeneration and high-resolution techniques to map neuronal connectivity. More broadly, our research goal is to determine rules that govern the connectivity, activity and robustness of neuronal networks that generate behavior.

Sensorimotor Quantification and Rehabilitation Laboratory

Chang Yaramothu, Director

The Sensorimotor Quantification and Rehabilitation Laboratory (SQRL) researches various methods of concussion diagnosis and rehabilitation to return people to their baseline. Concussions or mild traumatic brain injuries can severely affect a person's quality of life or even prevent them from routine actions. Symptoms include headache, light sensitivity, nausea and fogginess, among others, which are caused in part by defects in the oculomotor (eye movement) and vestibular (balance) systems. Diagnosis is currently based on patient symptoms and there are few accurate and reliable objective assessments. At SQRL, we utilize portable technology, such as virtual reality (VR) headsets, to obtain objective, quantifiable metrics to detect concussions. In future work, we will use the same VR headsets to aid in the rehabilitation process. We are currently conducting preliminary research on children, NJIT athletes and veterans.

Structural Ecology Lab

Gareth Russell, Director

Members of the Structural Ecology Lab are interested in how the distribution and movement of organisms is affected by the physical and social structure of their environment. Within this arena, we gravitate towards applied conservation questions, such as how landscape alterations caused by humans impact the ability of animals to survive and prosper. After earlier work looking at how the spatial structure of islands and habitat fragmentation impact extinction risk, we have been focusing on animal movement. In particular, we are trying to understand why group-living animals follow particular movement paths in landscapes that have both physical structure, such as vegetation patches, and social structure, meaning the presence of other individuals. For example, a current question is whether social networks can be discovered from group movement patterns, and in turn how the social networks determine those movements. For this, we are using GPS-collared African elephants as our study system. We are also interested in the use of emerging tracking and identification technology for ecology and conservation.

Swarm Lab

Simon Garnier, Director

The Swarm Lab is an interdisciplinary research unit that explores the mechanisms of swarm intelligence. We study how information is exchanged and transformed during interactions between members of a group and how this leads to "intelligent" group behaviors. We focus on the coordination of large animal groups, such as ant colonies, ungulate herds, baboon troops and human crowds. We use this knowledge to develop applications to problems such as the organization of pedestrian traffic and the control of miniature robotic swarms. We collaborate with biologists, social scientists, physicists, mathematicians and computer scientists around the world to elucidate the principles that underlie collective behavior across levels of biological and social organization. Current projects include research into the decision-making abilities of neuron-less organisms such as the slime mold; the organization of traffic and supply chains in leaf-cutting ants; the dynamic construction behavior of nomadic army ants; the role of vocal communication in the coordination of activities in mammal groups; the impact of poaching on movement decisions and social structure in African elephant herds; and the application of swarm intelligence principles to predictive policing software.

Vision and Neural Engineering Laboratory

Tara Alvarez, Director

Convergence Insufficiency (CI) is a prevalent binocular vision disorder that disrupts coordination of the eyes as they turn inward to focus on a near object. Symptoms, which include double and blurred vision, eyestrain and headaches during reading or other close work, negatively impact activities of daily living and can significantly impair a child's ability to focus and learn, for example. CI is present in about 5 percent of the population; just over a quarter of these patients do not improve even with validated therapy. While office-based therapy is effective in about 75 percent of patients with CI, home-based therapies are no more effective than a placebo. Our National Institutes of Health-funded project studies two potential mechanisms that may cause CI that we believe could be improved through therapy. This knowledge could lead to targeted therapeutic interventions, improved treatment success rates, reduction in the time to remediation and reduced healthcare costs. The Laboratory is also funded by a life-science focused venture capital fund and through an IEEE EPICS grant to develop a virtual reality-game therapy device with NJIT's Computer Gaming Program, Salus University and The Children's Hospital of Philadelphia.

Zebrafish Neural Circuits and Behavior Laboratory

Kristen Severi, Director

The Zebrafish Neural Circuits and Behavior Laboratory researches the neural circuits underlying locomotor behavior in the larval zebrafish. These tiny fish with transparent bodies are ideal for studying in real time how the brain and spinal cord work together to produce everyday movements the fish needs to swim around its environment. The techniques we employ are multidisciplinary, including high-speed behavioral recordings and analysis, dynamic imaging of calcium activity within populations of neurons and electrophysiology. Using these techniques, we try to understand what specific circuits are essential for performing different motor actions and how those circuits are wired together.

DATA SCIENCE AND MANAGEMENT

Institute for Data Science

David Bader, Director

The Institute for Data Science (IDS) focuses on interdisciplinary research and development in all areas pertinent to solving real-world problems using data, including health care, financial management, cybersecurity, food safety, manufacturing and smart cities, to name a few. The institute is composed of existing research centers in big data, medical informatics and cybersecurity, as well as new centers in data analytics and artificial intelligence; the centers conduct both basic and applied research and cut across all NJIT colleges and schools. Beyond academic research, the institute interacts closely with the outside world to identify and solve important problems in the modern data-driven economy. In collaboration with NVIDIA, a leading technology company that makes GPU accelerators such as the DGX Deep Learning server, for example, IDS is contributing to RAPIDS.ai, an open GPU data science framework for accelerating end-to-end data science and analytics pipelines entirely on GPUs. These new analytics pipelines are more energy-efficient and run significantly faster, which is critical for making swift, data-driven decisions. The institute also emphasizes multidisciplinary research and workforce skills training to develop technology leaders who will solve global challenges involving data and high performance computing.

Henry J. and Edna D. Leir Research Institute for Business, Technology and Society

Michael Ehrlich, Director

The Henry J. and Edna D. Leir Research Institute for Business, Technology and Society (LRI) focuses on some of the most critical global challenges facing business and society today: the impacts of climate change and other disruptive societal and operational events on corporate sustainability and business continuity. LRI has an integrated, dual mission of innovative business research and targeted outreach necessary to realize the institute's overarching goal of helping business and industry to become more eco-efficient, resilient and sustainable. The LRI's research builds upon and leverages decades of NJIT experience and intellectual capital in the fields of sustainability and industrial ecology, environmental science, operations management and decision analytics, organizational behavior and business data science. In addition to conducting business and management research, the LRI works closely on problems with academic and business communities, regional economic leaders and government agencies. New cognitive business and machine learning methodologies, designed to help companies collect, visualize and analyze data from wide-ranging sources, are viewed as central to these efforts.

New Jersey Innovation Institute

Simon Nynens, CEO

The New Jersey Innovation Institute (NJII) is an NJIT corporation focused on helping private enterprise meet the grand challenges shared across an entire sector while also helping individual companies innovate new product or market opportunities and develop new strategic business partnerships that embrace emerging technology. It is unique in its formation and role as a not-for-profit corporation in pursuit of economic development and in its agility in transforming intellectual capital into commercial success. More broadly, NJII is driving economic-cluster development, entrepreneurship and enterprise expansion. NJII has strategically organized Innovation Labs (iLabs) serving market verticals to follow industry-led agendas. The five initial iLabs serving as the catalyst for collaboration among the academic, private and public sectors are:

- Healthcare Delivery Systems: NJII helps create new models of evidence-based healthcare. Building on the secure exchange of digital information, these new delivery systems improve the quality of care and foster new medical-device technology to lower costs and improve outcomes.
- Biotechnology and Pharmaceutical Innovation: NJII helps pharmaceutical companies develop and apply innovative, cost-saving manufacturing technologies and works with biotechnology firms to scale innovation from lab to commercial production.
- Civil Infrastructure Policy and Planning and Smart City: Drawing on leading-edge engineering and materials science, NJII works with partners on innovative solutions to upgrade public infrastructures and develop resilient systems to withstand natural disasters. Solutions include advanced materials, new design and construction methods, and smart building and sensor technologies.
- Defense and Homeland Security: NJII helps address the demands of national security and defense, including port security, biometric and sensor-based detection systems, unmanned systems, weapons, energetics and material logistics, as well as communications projects and security systems for infrastructure defense, command, control and first-responder support.
- Financial Services: NJII partners with financial and information-technology professionals on issues ranging from identifying and mitigating the impact of financial bubbles to developing and implementing new supply chain management systems, data analytics for applications ranging from computer-based trading to actuarial assessment, and application design to facilitate new customer services.

Center for Applied Mathematics and Statistics

Michael Siegel, Director, and Cyrill Muratov, Associate Director

The Center for Applied Mathematics and Statistics (CAMS) is an interdisciplinary research center dedicated to supporting research in the mathematical sciences. CAMS researchers work on the modeling and simulation of complex systems with applications to fluids and materials, biological systems and electromagnetic phenomena. There are also significant efforts in nonlinear partial differential equations, optimization, statistics and data science. Research techniques involve developing new models, as well as novel numerical algorithms. Our research approach is interdisciplinary and involves collaborations with colleagues from a variety of disciplines at NJIT, as well as nationally and internationally. CAMS brings researchers from academia, industry and government to NJIT by organizing the annual "Frontiers in Applied and Computational Mathematics" meeting and other workshops. The center maintains a high-performance computer cluster for the use of its members, and runs a weekly colloquium on applied mathematics and statistics. We also organize a seminar series in mathematical biology, fluid dynamics and wave propagation, and applied statistics. CAMS supports the submission of interdisciplinary research proposals and a summer program for graduate students.

Center for Big Data

Chase Wu and Dantong Yu, Co-Directors

The mission of the Center for Big Data is to synergize expertise in various disciplines across the NJIT campus and build a unified platform that embodies a rich set of big data-enabling technologies and services with optimized performance to facilitate research collaboration and scientific discovery. Current research projects at the center focus on the development of high-performance networking and computing technologies to support big data applications. We are building fast, reliable data-transfer systems to help users in a wide spectrum of scientific domains move big data over long distances for collaborative data analytics. We are also developing high-performance workflow processes to manage the execution and optimize the performance of large-scale scientific workflows in various big data computing environments, including Hadoop/MapReduce and Spark. Furthermore, we are developing new machine-learning, data-mining and data-management techniques to address volume, variety, velocity, variability, and veracity challenges to enable big data analytics and predictive modeling in real-life applications. For example, we are developing a platform for analyzing user-contributed social media data to discover adverse drug effects, a leading cause of death. We are also developing data-driven methods to analyze web-page browsing behaviors to better understand user needs as well as the economics that sustain the free Web. These projects have been supported by the Leir Charitable Foundations, the National Science Foundation and Google.

Center for Computational Heliophysics

Alexander Kosovichev, Director

The primary goal of the Center for Computational Heliophysics is to develop data analysis and modeling tools in the area of heliophysics – the study and prediction of the Sun's magnetic activity – by combining expertise from computer scientists in the Ying Wu College of Computing with that of physicists and mathematicians in the College of Science and Liberal Arts. We work in partnership with NASA's Advanced Supercomputing Division at the NASA Ames Research Center. The Center is involved in the NSF EarthCube initiative to transform geoscience research by developing cyberinfrastructure to improve access, sharing, visualization and analysis of all forms of geosciences data and related resources. The Center's work is focused on novel, innovative approaches, including the development of intelligent databases, automatic feature identification and classification, machine-learning, realistic numeric simulations based on first-physics principles and observational data modeling. The Center develops synergies among these approaches to make substantial advances in heliophysics and computer science. Our new methods and tools can be used in broader scientific and engineering applications for developing new approaches to intelligent big data databases, as well as for image recognition and characterization methodologies.

Cybersecurity Research Center

Kurt Rohloff and Reza Curtmola, Co-Directors

Cyber technologies are critical in modern society and include communication networks, hand-held computers, cloud computing environments and embedded computing technologies that are integrated into all modern automobiles, airplanes and military systems. The Cybersecurity Research Center seeks to address ongoing and long-term future cybersecurity needs for protection and further economic development across the State of New Jersey, nationally and internationally. The Center develops new methods for understanding how modern cyber systems can be compromised and fail, how to design cyber systems so they are secure, and how to improve or fix the cyber infrastructure that has already been deployed. Current areas of investigation to address these challenges include developing and applying new approaches to practical encryption, secure cloud-computing services, privacy technologies, improved software engineering techniques, better data-encoding and communication protocols, and research on human factors. The Center is primarily affiliated with the Ying Wu College of Computing, but is intended to be highly collaborative and inclusive, with the goal of including and supporting collaboration with researchers outside of the college and with researchers and practitioners outside of the university. The Center is supported exclusively through external research funds, including from the U.S. Department of Defense and the National Science Foundation. Current collaborators include MIT, École Polytechnique Fédérale de Lausanne, Raytheon and the U.S. Navy's Space and Naval Warfare Systems Command, among others.

Leir Center for Financial Bubble Research

Zhipeng Yan, Director

The Leir Center for Financial Bubble Research seeks to understand through quantitative and qualitative research how asset bubbles can be identified, including their stages of development and the policies that can best manage impacts. The center examines financial crises and asset bubbles with the goal of developing a more precise understanding of what constitutes a bubble and what does not. Behavioral characteristics such as over-optimism or herding regarding policy, investments and contracts are areas of inquiry. Importantly, the center's objective is to take an approach to bubble research that focuses on analyzing bubbles in ways that are meant to be useful to practitioners. Our research on the links between disruptive technologies, social media movements and bubbles will have relevance for the study of entrepreneurship, which is another focus for the Martin Tuchman School of Management. Outside of academia, we expect significant interest within the financial community and by relevant government regulators.

National Science Foundation I-Corps Program Center

Michael Ehrlich, Principal Investigator

The National Science Foundation (NSF) I-Corps Program center at NJIT offers specialized training and mini-grants to teams with an interest in exploring the commercial viability of their ideas for products and businesses that are based on their own inventions, NJIT intellectual property or any university-derived STEM-related technology. Grantees will embark on commercialization of new technologies, products and processes that arise from the institution. We build formal, active, local innovation ecosystems that contribute to a large national network of mentors, researchers, entrepreneurs and investors, and we encourage collaboration between academia and industry. The campus I-Corps site has supported between 35 and 40 teams for each of the last six years. Overall, our teams have performed extremely well and have gone on to win further follow-on grants and other funding. Twenty-five faculty/student teams have won NSF I-Corps Teams grants of $50,000 each, as well as approximately 25 additional awards from the N.J. Health Foundation, NSF Partnership for Innovation grants and NSF Small Business Innovation Research grants, among others. We are especially proud of our recruitment of underrepresented entrepreneurs, including women and underrepresented minorities. Teams led by underrepresented entrepreneurs, either with student entrepreneurial leads and/or faculty technical leads, compose about 85% of our teams over the last couple of years.

New Jersey Innovation Acceleration Center

Michael Ehrlich, Director

The New Jersey Innovation Acceleration Center (NJIAC) is a resource for entrepreneurs and innovators from throughout the region, with a focus on students and faculty at NJIT, as well as members of the Newark and, more broadly, North Jersey communities. Partnering with VentureLink, we offer a full range of services, from business incubation to new business training, among other resources. Our mission is to help innovators accelerate their time to market and to revenue metrics. Among other activities, the NJIAC sponsors the NJIT Entrepreneurs Society, TEDxNJIT and the New Business Model Competition (with support from Capital One Bank, Synchrony Bank, Edison Foundation and others), which is open to both students and community members from throughout North Jersey. This year's 12th annual competition was held virtually and attracted the largest attendance ever. The winners and finalists of the NBMC are invited to participate in the 10-week NJIT Lean Startup Summer Accelerator program, in which we help new companies launch and quickly achieve their first revenues.

Structural Analysis of Biomedical Ontologies Center

Yehoshua Perl and James Geller, Co-Directors

The Structural Analysis of Biomedical Ontologies Center (SABOC) is an interdisciplinary research center linking computer science and medicine. It deals with medical terminologies and ontologies, a subject of study that is a sub-field of medical informatics. Many biomedical terminologies are measured in the tens of thousands to hundreds of thousands of terms, including drug names and their chemical ingredients, symptoms, diagnoses, body parts, medical procedures, medical devices, infectious agents and accidents, among others. Understanding these terms and finding inconsistencies with textual representations is difficult, and we therefore use graphical representations: biomedical terminologies appear as networks in which the terms are symbolized as boxes and the relationships between pairs of terms are symbolized as arrows. Without a sophisticated approach, visualizing these networks on a computer screen can lead to failure. The core research efforts of SABOC are to develop small abstraction networks that summarize large biomedical terminologies; to visualize abstraction networks on a computer screen in a manner that is easier to comprehend than the original terminologies; and to perform quality assurance on the original terminologies by using the abstraction networks to find and remove inconsistencies. As biomedical terminologies are increasingly used in applications such as electronic health records, ensuring that terminologies are free of inconsistencies helps ensure the correctness of these applications. SABOC is currently funded by a three-year, $1.75 million grant from the National Institutes of Health.

The Elisha Yegal Barn-Ness Center for Wireless Information Processing

Alexander Haimovich, Director

The Elisha Yegal Bar-Ness Center for Wireless Information Processing (CWiP) engages in a broad range of research in diverse areas of wireless communications, signal processing and radar. The center serves as a collaboration hub of faculty, visiting scholars, post-doctoral fellows, graduate and undergraduate students. Current main areas of research include 5G wireless mobile networks, cloud radio access networks, sensor networks, information theory cooperative networks, machine learning radar and acoustics communications.

VentureLink

William Lutz, Director

Formerly known as the Enterprise Development Center, VentureLink is a community hub for technology companies at NJIT for Northern New Jersey. The organization provides space and services to startups that are pre-revenue, pre-legal formation and pre-product market fit, as well as to established tech companies that need a place to grow. VentureLink operates within the NJIT campus, providing in-residence companies with weekly programming, workspace and expert mentorship; its aim is for companies to hone entrepreneurial skills by learning experientially.

Advanced Networking Laboratory

Nirwan Ansari, Director

The Advanced Networking Laboratory (ANL) engages in research to improve the performance and dependability of telecommunications networks. The goals of the ANL are to identify, model, simulate and demonstrate next-generation networking technologies; to add to the knowledge base for next-generation networks; to train tomorrow's networkengineering innovators; and to foster industrial collaboration and international partnerships. ANL worked with NEC America and Huawei, for example, to improve passive optical networks. The National Science Foundation (NSF) has supported the lab's investigations into new ways to provide services to a growing set of traffic classes in next-generation networks. Other recent projects that have been funded by NSF include: SoarNet, which leverages free space optics – the use of light in free space to wirelessly transmit data – as backhaul and energizer for drone-assisted networking; FreeNet, Cognitive Wireless Networking Powered by Green Energy, which liberates wireless access networks from spectral and energy constraints; Greening at the Edges, which creates mechanisms for making the access portion of communications infrastructure more energy-efficient; REPWiNet (Renewable Energy Powered Wireless Networks), which aims to efficiently power future wireless networks with renewable energy; and Fast Autonomic Traffic Congestion Monitoring and Incident Detection, which seeks to provision real-time traffic monitoring through advanced networking, edge computing and video analytics.

Big Data Analytics Lab

Senjuti Basu Roy, Director

The Big Data Analytics Lab (BDaL) is an interdisciplinary research laboratory with a focus on large-scale data analytics problems that arise in different application domains and disciplines. One of the primary goals of our lab is to investigate an alternative computational paradigm that involves "humans-in-the-loop" for large-scale analytics problems. These problems come up at different stages in a traditional data science pipeline, including data cleaning, query answering, ad-hoc data exploration and predictive modeling, while also presenting in emerging applications. We study optimization opportunities that can be exploited in these unique man-machine collaborations, and address data management and computational challenges to enable large scale-analytics with humans-in-the-loop. Our focus domains are social networks, healthcare, climate science, retail and business and spatial data. The research projects at BDaL are funded by the National Science Foundation, the Office of Naval Research, the National Institutes of Health and Microsoft Research.

Design Computation Lab

Taro Narahara, Director

The Design Computation Lab investigates new ways that computational technologies and intelligence can support, enhance and change the way people design through the use of advanced algorithms in AI, immersive VR, innovative UX/UI and robotics. Our patent-pending method, based on our current multidisciplinary collaboration work with data scientists at the University of Tokyo, offers a wide range of potential applications in the real estate and architecture industries, such as apartment-searching tools and layout synthesis tools. To the best of our knowledge, our work is the first to propose a highly accurate prediction model for the subjective functionality and comfort of apartments using machine learning. We were awarded the 2020 Human Communication Award from the Institute of Electronics, Information, and Communication Engineers (IEICE) Japan for best paper. Our goal is to gain a scientific understanding of professional decisions made by architects, real estate planners and urban designers that influence the quality of their spatial designs.

Laboratory for Discrete Event Systems

MengChu Zhou

The Laboratory for Discrete Event Systems explores the theory and application of such formal methods as Petri nets and automata to model, analyze, control, evaluate and simulate complex engineering systems. By combining them with mathematical optimization theory, the Internet of Things, big data analytics, artificial intelligence, machine learning and intelligent optimization methods, the lab offers many powerful methodologies and tools to advance a wide range of systems and processes. They include wafer fabrication, flexible manufacturing, intelligent transportation, oil refinery, water processing, steel production, electronics manufacturing, high-speed rail transportation, disassembly, and de-manufacturing. Over the past three decades, the lab has produced more than 900 papers, including more than 500 IEEE Transactions journal papers, 28 patents, 29 book chapters and 12 books. They have been used by industrial firms, leading to significant economic and societal impact.

FinTech Lab

Grace Wang, Director

Rapid technology advances and innovations in machine learning, data mining, blockchain and mobile computing, among other technical fields, are reshaping the financial industry and the way that financial services are delivered. Crowdfunding, cryptocurrency, mobile banking, and e-payment are examples of new processes and products in the new FinTech era. The FinTech Lab pursues interdisciplinary research involving in data science, computer science and finance to provide insights into financial data, to improve the efficiency of financial operations and deliver innovative financial services. The lab also provides students training in FinTech to prepare them to be financial industry professionals with a unique skill set.

Geriatric Engineering Technology Lab

David Lubliner, Director

The Geriatric Engineering Technology Lab engages School of Applied Engineering and Technology students in hands-on research projects that involve designing intelligent living environments to support independent living by individuals over the age of sixty-five. The lab contains both Arduino micro controllers and quad-core Linux Raspberry Pi systems to interface with and program sensors, motors and cameras, among other devices. In addition, students work on advanced design projects in gait analysis, facial recognition and proactive AI software to assist individuals as they age. Advisory group members in this age group interact with students to ensure their designs meet the needs of the target community, while internships with companies such as CISCO and Johnson & Johnson help refine their design projects. Students teams have the opportunity to commercialize their designs through the National Science Foundation I-Corps program based on NJIT's campus.

Gidget Lab – (G)ender-(I)nclusive (D)esign, (G)ame and (E)ducational (T)echnology Lab

Michael Lee, Director

The Gidget Lab (gidgetlab.com) examines various ways in which technology can better inform, engage and teach diverse learners a range of STEM topics. We build tools and study new technologies to attract more people and increase diversity in STEM. Our free computing education game, Gidget (helpgidget.org) has helped thousands of people across the globe to learn introductory programming concepts; nearly half the users are girls and women. The lab runs Newark Kids Code (newarkkidscode.org), a weekly program that assists middle school students in Newark, N.J. in learning programming and website design. We also work with local high schools to teach chemistry using virtual reality headsets. Our lab is funded by the National Science Foundation, the N.J. Department of Education and Oculus Research.

GIScience & Remote Sensing Laboratory

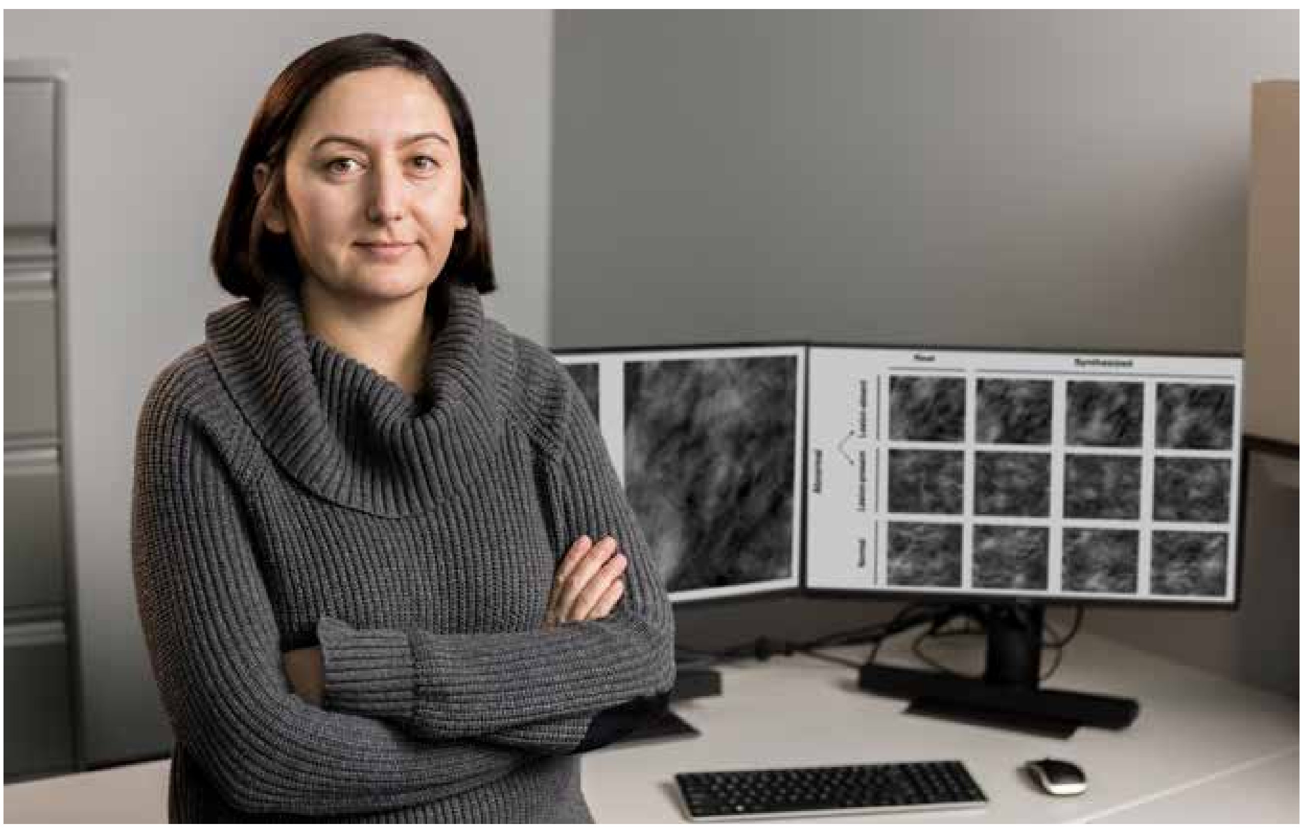
Huiran Jin, Director

The GIScience & Remote Sensing Laboratory focuses on the advancement of geospatial analysis and quantitative modeling of environmental changes at regional to global scales. Remotely sensed data acquired by various airborne and spaceborne sensing systems, such as multi/hyperspectral and thermal sensors, synthetic aperture radar (SAR), light detection and ranging (LiDAR) and unmanned aerial vehicles (UAVs, are used in conjunction with geographic information system (GIS) techniques and quantitative analytics to address a range of social and environmental issues. Research topics include land-cover and land-use mapping, urban growth detection, natural disaster management and monitoring of wetland inundation dynamics for methane flux estimation. The methodologies we use include big data processing, spatiotemporal analysis, land-surface modeling and decision-support algorithm development for an improved understanding of the Earth.

High-Performance Computing Lab

Qing Gary Liu, Director

The overarching goal of the High Performance Computing Lab (HPCL) is to research and develop methodologies and software tools to accelerate discovery on large scientific instruments, such as supercomputers, and at experimental and observational facilities. Our mission is to not only develop new ideas and advance knowledge, but to also work with computing facilities to develop hardened solutions that can benefit various science and engineering disciplines. HPCL researchers have successfully deployed software into various production environments, such as the U.S. Department of Energy's computing systems, National Science Foundation computing centers and U.S. Department of Defense computing centers. An estimated usage of software developed by HPCL researchers is 1 billion computing hours each year. The HPCL lab provides research and educational opportunities involving computer science and engineering, applied math, and computational engineering. Research activities are focused in the broad areas of parallel and distributed computing, data analytics and high-speed networking.



Laboratory for High-Performance Data Signal Processors & Data Engineering Research

Ali Akansu, Director

IT-centric and data-intensive scientific discovery offers boundless opportunities for impact on complex systems, as well as the means to infer intelligence and actionable information from big data. The field requires cutting-edge high-performance computing, internet and data engineering expertise, strongly coupled with mathematics. Many industries and businesses have already built state-of-the-art data and information processing infrastructure for their operations. The Laboratory for High-Performance Data Signal Processors (DSP) & Data Engineering Research (HPDER) is a research and development laboratory that advances the theory and implementation of analytically oriented high-performance DSP, machine learning and data engineering methods to address big data and signal processing problems of various application domains, ranging from quantitative finance to data networks. Current projects include explainable machine learning methods and algorithmic trading for U.S. equities.

Networked Controls and Intelligent Diagnostics Laboratory

Mohsen Azizi, Director

The Networked Controls and Intelligent Diagnostics (NCID) Laboratory focuses on the design and development of controllers and fault diagnosis algorithms that target the optimal and robust performance of industrial and dynamic systems. Decentralized control techniques are specifically designed for large-scale dynamic systems in which computation resources are distributed and communication bandwidth is limited. Moreover, hybrid diagnostics algorithms are designed based on a combination of classical and artificial intelligence-based fault diagnosis techniques that aim at the resilient and reconfigurable performance of dynamic systems in the presence of faults and failures. These control and fault diagnosis algorithms are developed for microgrids and renewable energy systems, and will be applied in the future to other applications, including autonomous vehicles, robotics and aerospace systems.

Networking Research Laboratory

Roberto Rojas-Cessa, Director

The Networking Research Laboratory performs cutting-edge research in computer networking and cyber-physical systems that challenges our current understanding and established practice. Members of the laboratory, including faculty and students, look into phenomena that help to advance the state-of the-art in computer networks, wired and wireless communications, applications and optimizations based on data and intelligent systems. The laboratory has contributed new knowledge to network measurement, network security, wireless and wired technologies, data center algorithms, and, more recently, to energy applications, blockchain and software-defined concepts. We perform scientific research, develop technology and analyze and design intelligent systems that improve our quality of life, while providing education and training at different levels of study. The laboratory is open to collaborations with other laboratories and researchers, sponsoring agencies and industry to seek practical and affordable solutions for communications and cyber-physical systems. Recent research includes the digitization of energy, wireless systems for communications on emergency and recovery scenarios, optimization of light-communication technologies for high-speed trains, new concepts of light-based communications and data analysis applications for research on COVID-19.

Operations Management Laboratory

Wenbo Selina Cai, Director

The Operations Management Laboratory seeks to advance understanding of the impact of key players' decision-making processes on the design, pricing and management of products and services in supply-chain management. Theories and methodologies in both operations research and microeconomics, such as stochastic processes, optimization and game theory, are used. Research topics include fostering private-public collaborations to reduce the impact on ash trees from invasive species, such as the emerald ash borer, through a cost-sharing program; accelerating the implementation of carbon-capture and storage (CCS) technology through the design of economic incentives and optimal service contracts among participants of CCS networks; improving the performance of primary healthcare services through stochastic scheduling and optimal capacity allocation among pre-scheduled and urgent patients; and examining the economic and environmental implications of adopting additive manufacturing technology in the retail and supply chain.

Optimized Networking Laboratory

Abdallah Khreishah, Director

The Optimized Networking Laboratory engages in research to improve the performance of wireless and wireline networks and to utilize these networks in emerging applications. The goals of the Lab are to identify, model, simulate and demonstrate proof-of-concept setups for next-generation networking technologies and to add to the knowledge base for next-generation networks, to train tomorrow's network-engineering innovators and to foster industrial collaboration and international partnerships. One future networking technology the Lab investigates is Visible-light Communications (VLC), in which indoor light fixtures are used to jointly perform communications and illumination. We spend 90 percent of our time indoors, where 80 percent of Internet traffic is generated. The Lab was the first to demonstrate a proof-of-concept setup that designs a cognitive Internet access system to leverage hybrid Radio Frequency (RF) access points or WiFi and VLC, an emerging concept. VLC has been extended to use very low-power Internet access for small Internet of Things (IoT) devices. With respect to the vehicular networks used by intelligent transportation systems, the Lab is exploring the emerging concept of edge computing to enhance wireless networks in order to solve several problems related to traffic monitoring systems and congestion control on the highways of New Jersey. The Lab is also investigating several wireless technologies for unmanned aerial vehicles and drones to help in situations such as emergency-response and recovery from natural disasters.

Social Interaction Laboratory

Donghee Yvette Wohn, Director

The Social Interaction Lab is an interdisciplinary research hub that combines psychology, communication, computing, and design to understand how people interact with technology, a field known as human-computer interaction (HCI). Some of our projects include understanding online harassment and content moderation on social media, examining new digital economies, studying remote communication/collaboration, and developing applications for health and wellbeing.

Systems Optimization and Analytics Laboratory

Ismet Esra Buyuktahtakin-Toy, Director

The Systems Optimization and Data Analytics laboratory (SODAL) conducts theoretical and applied research on integrated large-scale mathematical optimization and data science, including model formulation and analysis, algorithm development and software implementation, in order to tackle complex systems problems and to develop optimal decision strategies. Students apply data analytics and optimization techniques in production planning and supply-chain systems, as well as in healthcare, the environment and energy systems, among others. Current research involves developing data-driven, risk-averse stochastic mixed-integer programming models and solution algorithms. Our applied research focuses on tackling epidemic diseases in forestry caused by invasive insects, for example, such as the emerald ash borer, and in healthcare, caused by pathogens such as SARS-CoV-2, the Ebola virus and the human immunodeficiency virus (HIV). Our lab has been funded by a National Science Foundation CAREER and EPSCoR grants, the U.S. Department of Agriculture, the U.S. Forest Service and the Kansas Board of Regents.

ENVIRONMENT AND SUSTAINABILITY

Institute for Space Weather Science

Haimin Wang, Director

The Institute for Space Weather Science (ISWS) promotes multi-disciplinary research and education on space, with a focus on the powerful bursts of electromagnetic radiation, energetic charged particles and magnetized plasma known as space weather. To understand and predict the physics of solar activities and their effects on space weather, the institute combines the strengths of three NJIT research centers – the Center for Solar-Terrestrial Research, the Center for Computational Heliophysics and the Center for Big Data. At the Institute's core is the Center for Solar-Terrestrial Research (CSTR). With its array of unique instruments on land and in space – the 1.6 meter Goode Solar Telescope, a newly expanded radio array with 15 antennas, instruments aboard NASA's Van Allen Probes spacecraft and devices deployed across Antarctica, to name a few – the center is uniquely poised to advance understanding of the genesis, acceleration and impact of solar storms, as well as to provide a comprehensive view of solar activity over months and years. Joining the CSTR are modeling and big data analytics experts at the Center for Computational Heliophysics, who partner with NASA's Advanced Supercomputing division at the NASA Ames Research Center, and researchers at the Center for Big Data. The latter's mission is to synergize expertise in various disciplines across the NJIT campus and to build a unified platform that embodies a rich set of big data-enabling technologies and services with optimized performance. Within two years of its establishment, the institute obtained a $850,000 National Science Foundation (NSF) EarthCube award, aimed at the transformation of geosciences research and education and sponsored through a partnership between the NSF Directorate of Geosciences and the Office of Advanced Cyberinfrastructure in the Directorate for Computer and Information Science and Engineering. It also established a Research Experiences for Undergraduates site through another NSF award.

Center for Community Systems

Colette Santasieri, Executive Director

The Center for Community Systems is a resource and conduit for creating thriving, sustainable and resilient communities. It is a strategic platform that connects innovative planners, engineers, environmental scientists, social scientists, architects and economists with government, industry and community organizations in order to solve complex problems. Communities exist within the context of varying and ever-evolving social, economic, political and cultural conditions. The pressures they experience include: increasing or decreasing populations; aging infrastructure, fiscal constraints, climate change, contaminated lands and natural and human-made disasters. These complexities and constraints may hinder a community's ability to grow and prosper in a sustainable and resilient manner.

The Center for Community Systems engages in cross-disciplinary collaborations designed to stimulate intellectual curiosity and foster innovative solutions to the challenges communities face. The center's multi-disciplinary staff of professionals design, develop and deploy technical assistance and tools, resources, such as infographics on state regulatory rules, how-to videos and case studies on brownfields redevelopment, and educational and engagement programs to communities to improve environmental conditions, spur economic development and advance social equity. The Center's focus areas include: brownfields redevelopment; community revitalization; transportation planning; land use planning; transit-oriented development; port-city relationships; and natural resources.

Center for Energy Efficiency, Resilience and Innovation

Haim Grebel, Director

The Center for Energy Efficiency, Resilience and Innovation (CEERI) conducts research and development, provides technical and educational assistance for the deployment of sustainable technologies and applications to manage energy and water resources, and promotes public awareness of energy resources. The activities of CEERI are interdisciplinary. With support from state, federal and business partners, CEERI's main focus is identifying and implementing cost-effective measures that reduce operating costs, environmental impacts in the deployment of sustainable technologies, and applications related to energy and water. The Center is a collaboration between industry and NJIT.

Center for Ethics and Responsible Research

Britt Holbrook, Director

To foster the core values of integrity and social responsibility outlined in the NJIT 2025 strategic plan, NJIT has established the new Center for Ethics and Responsible Research (CER2). At the cutting edge of research in ethics and ethics education, CER2 promotes experiential learning via experimental pedagogical approaches and helps develop the means to evaluate those approaches. With grants from the National Science Foundation and the New Venture Fund, and in collaborative projects with colleagues at the University of Florida, Harvard University, Stanford University, the University of South Florida, Rowan University and the University of Connecticut, CER2 is working to instill a culture of ethics in both NJIT faculty and students. Faculty teach students about ethical and responsible research not only through standalone ethics courses, but also by modeling ethical behavior in their own research and practice. Students are our future researchers, professionals and practicing engineers, and educating them in ethical and responsible research – via both direct and indirect instruction – will have broad impacts on society.

Polar Engineering Development Center

Andrew Gerrard, Director

The Polar Engineering Development Center (PEDC), housed within NJIT's Center for Solar-Terrestrial Research, consists of a highly skilled group of professors, research scientists, electrical and mechanical engineers and technicians who bring decades of experience in instrument and hardware design for deployment at high latitudes and Polar regions. The group was formed in the 1980s as part of the National Science Foundation-supported Automatic Geophysical Observatory (AGO) program, which operates to this day on projects active across the Antarctic ice shelf. Today, the PEDC is reaching out to serve the broader astrophysical and geospace scientific communities conducting research in Polar environments by providing support in the areas of sustainable "green" power generation in the 10-W to 100-W range; power conditioning and control; robust engineering for Polar climates; data acquisition techniques, units, and transmission services; and general Polar field support. As an NSF-sponsored facility, the PEDC manages instruments at South Pole Station, McMurdo Station, Palmer Station and across the Antarctic ice shelf.

Center for Solar-Terrestrial Research

Andrew Gerrard, Director

The Center for Solar-Terrestrial Research (CSTR) is an international leader in ground- and space-based solar and terrestrial physics, with a particular interest in understanding the effects of the Sun on the geospace environment. CSTR operates the Big Bear Solar Observatory and Owens Valley Solar Array in California, the Jeffer Observatory at Jenny Jump State Forrest in New Jersey and the Automated Geophysical Observatories distributed across the Antarctic ice shelf. The CSTR also manages a large number of instruments at South Pole Station, McMurdo Station and across South America and the United States. CSTR is one of the principal investigators in NASA's Van Allen Probes mission, which explores the radiation and plasma environment around Earth, and houses the Space Weather Research Laboratory, which conducts scientific research in the area of space weather with the mission to understand and forecast the magnetic activity of the Sun and its impact on Earth. Such instrumentation and data resources enable scientific studies ranging from the Sun's surface to its extended atmosphere, and into Earth's atmosphere.

Center for Solar-Terrestrial Research–Big Bear Solar Observatory

Wenda Cao, Director

The Center for Solar-Terrestrial Research operates Big Bear Solar Observatory (BBSO) in California, which houses the high-resolution 1.6-meter Goode Solar Telescope, the only telescope in the world that can follow its target on the Sun continuously for several hours with high spatial resolution better than 100 kilometers. With its state-of-the-art adaptive optics and scientific instrumentation, the telescope obtains high-resolution views of the Sun's surface features, such as sunspots, granulation, filaments, faculae, spicules and jets. Its instruments measure the magnetic fields and motions of these features to understand the basic physics of solar activity that affect the Earth and near-Earth technological systems. Through the BBSO telescope, NJIT scientists have explored how twisted magnetic fields interact to produce the sudden release of energy that powers solar flares, and have unveiled ground-breaking insights into the generation mechanism of many spicules and their possible contribution to coronal heating. Using data from multiple NASA solar spacecraft and advanced computer modeling, we are developing an understanding of fundamental processes that improve our ability to predict the occurrence and outcomes of such solar activity on the Earth.

Center for Solar-Terrestrial Research–Expanded Owens Valley Solar Array

Dale Gary, Director

The Center for Solar-Terrestrial Research (CSTR) operates the Expanded Owens Valley Solar Array in California, a recently completed major expansion operating as one of the most capable solar-dedicated radio arrays in the world. The array consists of 14 antennas and is used to image solar flares at hundreds of frequencies over the frequency range 1-18 GHz within one second. Its ability to follow evolving radio emissions with such high frequency and time resolution allows us to capture and quantify the energy release, acceleration and transport of energy in flares. In addition, the array images the slower timescale emissions of sunspot regions on 30-minute timescales, and the full disk of the Sun on 6-12-hour timescales. Among other advantages, such data provide dynamic measurements of the coronal magnetic field in flares and maps of magnetic field strength 30,000 miles above the Sun's surface. This has opened a new window on the processes of solar activity. Our research has included the discovery that radio emissions from the Sun can directly and adversely affect cellular communications and navigation systems, such as GPS and radar.

Otto H. York Center for Environmental Engineering and Science

Somenath Mitra, Director

The Otto H. York Center for Environmental Engineering and Science offers core research facilities as a resource for many interdisciplinary research programs and initiatives. The Center was the first building in the nation specifically constructed for cooperative public and private research in hazardous waste management. Today, it has diversified into many other areas, with research projects in nanotechnology, drug-delivery systems, particle engineering, microfluidics, membrane science, environmental science and engineering and biomedical engineering. Researchers from a range of disciplines — chemistry, environmental science, chemical engineering, biomedical engineering, mechanical engineering, material science and pharmaceutical engineering — have laboratories in the center with extensive facilities in microscopy, mass spectrometry and material characterization. York Center research projects are funded with faculty grants from agencies such as the National Science Foundation, the National Institutes of Health, the National Institute of Environmental Health Sciences and the U.S. Department of Defense, as well as from leading industries. The new Life Science and Engineering Center associated with the York Center provides additional shared laboratory space for interdisciplinary projects. The York Center supplies Faculty Instrument Usage Seed Grants (FIUSG) for the use of core laboratories in order to support faculty and to promote research across campus by providing free instrument time to pursue preliminary findings that will lead to the development of new ideas and grant proposals. The FIUSG initiative aims to support the launch of new initiatives in core and emerging interdisciplinary areas aligned with NJIT's strategic interests.

Advanced Energy Systems and Microdevices Laboratory

Eon Soo Lee, Director

The Advanced Energy Systems and Microdevices Laboratory is dedicated to research on new nanomaterials for advanced energy systems and new microdevices for disease detection and diagnosis for biomedical applications. The Lab's energy research focuses on the non-platinum group of metal (non-PGM) catalysts to replace PGM catalysts for electrochemical-energy systems, such as fuel cells and batteries, and industrial applications such as filtering systems and petroleum-processing systems. Principal research includes synthesizing and characterizing new, high-performance non-PGM catalysts from carbon materials such as graphene, and understanding the fundamental mechanisms of the reaction. The Lab's microdevices research concentrates on applying micro- and nanotechnology to diagnose complex diseases, such as cancers, at their early stages using a nano-biochip. The biochip incorporates microchannels with a self-driven flow mechanism of biofluid and nanocircuits to sense the existence and the level of severity of a disease with high sensitivity and selectivity. Our research has been supported by the National Science Foundation, the New Jersey Health Foundation, NJIT and a private company, Abonics, Inc.; we work in collaboration with and support from the John Theurer Cancer Center at Hackensack University Medical Center, Brookhaven National Laboratory-Center for Functional Nanomaterials, CUNY's Advanced Science Research Center, Rutgers University and Montclair State University. We have obtained several patents for our technology innovations.

Analytical Chemistry and Nanotechnology Laboratory

Somenath Mitra, Director

The Analytical Chemistry and Nanotechnology Laboratory is located in the Department of Chemistry and Environmental Science. Our research focuses on the fields of analytical chemistry, nanotechnology and water treatment. In analytical chemistry, we develop instrumentation for online and real-time monitoring analysis, environmental monitoring, field-portable instruments and microfluidic devices. In nanotechnology, we work on nanoparticles, particularly nanocarbons such as carbon nanotubes and graphene, with applications in the energy and environmental technologies sectors. In the area of energy, we focus mainly on batteries and supercapacitors, with prior work on solar cells. To improve water quality, we develop novel sorbents and membranes, for which our main thrust is desalination and water treatment. Our work on nanocarbon-based membranes focuses on various associated applications, such as membrane distillation. And lastly, to improve drug-delivery systems, we use nanotechnology to make hydrophobic drugs dissolve more effectively.

Laboratory of Applied Biogeochemistry for Environmental Sustainability

Lucia Rodriguez-Freire, Director

The goal of the Laboratory of Applied Biogeochemistry for Environmental Sustainability is to understand and control the complex mechanisms of contaminant transformations in natural and engineered environments in order to engineer remediation and resource recovery technologies that mimic natural sustainable processes. Biogeochemical interactions play a key role in controlling the speciation and mobility of metals in the environment through direct metabolic processes such as metal uptake, biotransformation and biomineralization, or indirectly by changing ambient redox/pH conditions, producing ligands or new biominerals and altering mineral surfaces. Current research projects include the biological-mediated recovery of valuable elements from wastes, such as rare earth elements from mine waste and biopolymers from wastewater; the design of biomimetic membranes for selective separation of heavy metals from wastewater; the description of the mechanisms affecting corrosion control in water distribution systems; and the investigation of transformations controlling the fate of metal and organic contaminants in rhizosphere horizons.

Atmospheric Chemistry Laboratory

Alexei Khalizov, Director

The Atmospheric Chemistry Laboratory investigates the origins of atmospheric pollution and evaluates its environmental impacts. We work at the junction of chemistry, physics and engineering to understand the processes that produce, modify and remove pollutants, and to develop new detection methods. We approach our research problems through laboratory experiments and modeling. Our two major research projects focus on aerosols and mercury in the atmosphere. In the aerosol project, we study how soot nanoparticles evolve during their atmospheric lifetime and evaluate their impacts on climate and air quality. The goal of our mercury project is to understand the broader atmospheric chemistry of this persistent, bioaccumulative pollutant emitted to the atmosphere by various activities, from coal combustion to artisanal gold mining. We study the gas-phase mercury oxidation and interactions of gaseous oxidized mercury with atmospheric surfaces, and develop highly sensitive mass spectrometry-based techniques for in situ atmospheric detection.

Building Dynamics Lab

Vera Parlac, Director

In the Building Dynamics Lab, we are interested in creating dynamic, adaptive and responsive architectural systems that lead to a more sustainable built environment. Our work is premised on the notion that buildings exist in a constantly changing context, yet, by being static and inactive, they don't fully respond to such dynamics. For example, if building envelopes can react dynamically to changes in the Sun's location, outside temperature and humidity levels, they could reduce substantially the amount of energy used for heating and cooling. If the size of building spaces, their internal configuration and environmental conditions can be adjusted on the fly, we could have buildings that better meet the needs of users and require even less energy for their operation. To enable buildings to effectively engage with changes in their surroundings and changes in their use, we experiment with novel responsive systems that integrate shape-changing materials and soft inflatable components, for example. We design and build prototypes of dynamic assemblies by taking advantage of contemporary advances in material, robotic, interactive and computation technologies. Ours is an interdisciplinary pursuit and we welcome others interested in collaborating with us.

Building Energy & Built Environment Laboratory

Hyojin Kim, Director

The Building Energy & Built Environment Laboratory, or (BE)2 LAB, was founded in 2013 to offer advanced learning and research opportunities and an environment for architecture and engineering students and others who wish to improve building energy efficiency and indoor environmental quality for occupant comfort and well-being through active involvement in research. The lab conducts research to create new knowledge and to advance measurement science in order to enable an integrative and rigorous assessment of whole-building performance using both computer simulation and field measurements. The lab aims to strike a balance between theoretical knowledge and practical applications. Our research has been funded by the National Institute of Standards and Technology, the U.S. Department of Energy, the U.S. Department of the Interior, Samsung Electronics and the American Society of Heating, Refrigerating and Air-Conditioning Engineers.

Digital Spatial History Lab

Louis Hamilton and Burcak Ozludil, Co-Directors

The Digital Spatial History Lab (DSHL) provides tools for researchers and students to conduct temporospatial analysis of historical and contemporary environments. Researchers address questions about society, culture, religion and medicine by using digital historical methods to examine the built environment. DSHL projects use 3D simulation, virtual reality, ontological modeling, mapping and agent-based modeling to allow users to move in scale from one building to an entire city and from one minute to several centuries. Current projects focus on the Mediterranean capitals of Rome and Istanbul from the thirteenth century to the twenty-first. The Rome project examines street shrines as an expression of vernacular devotion, revealing hidden communities and exploring forces that shape individual devotion—from politics, to urban infrastructure, to tourism. The Istanbul project analyzes and maps medical spaces to uncover the history of Ottoman/Turkish psychiatry, reconstructing the daily life and medical routines within mental hospitals.

Laboratory of Environmental Microbiology and Biotechnology

Mengyan Li, Director

The Laboratory of Environmental Microbiology and Biotechnology seeks to make advances in the fields of applied microbiology and molecular biotechnology, and to develop innovative techniques to mitigate and address environmental issues related to water and energy. We develop water remediation techniques that deploy microorganisms to biodegrade organic pollutants of emerging global concern. We further research interdisciplinary methods to improve urban water treatment technologies, including the application of nanotechnology to disinfect supplies contaminated with pathogens, and we use biomass-derived charcoal to remove metal toxins. We employ surrogate and indicator microorganisms to investigate the potential impacts of engineered nanomaterials and disinfection byproducts once they are released into the environment. To examine the microbial processes in natural and engineered systems, we integrate conventional culture-dependent approaches with state-of-the-art high-throughput molecular technologies, such as cloning, microarray, metagenomics and next-generation sequencing. We design innovative and inexpensive genetic forensic tools for the rapid quantification of microbial populations and functions in the environment. Other projects include mitigation of biofouling in membrane-treatment facilities, the control of microbe-induced corrosion, and the identification of microbial enzymes for biofuel production.

Environmental Systems Lab

Lisa Axe, Director

The Environmental Systems Lab focuses on chemical and physical processes in environmental systems. Researchers in the group use a suite of analyses to study the effects of surface chemistry on contaminant transport and attenuation. Recent projects include work with the water company SUEZ North America on converting filters and adsorbents used in water treatment plants into biologically active filters for the additional purpose of treating emerging contaminants that involve pharmaceuticals, personal healthcare products and pesticides. The Lab studies biologically active filters with equipment that includes a TOC analyzer, nutrient analyses and ATP analysis. Additionally, Chemours Company is supporting the Lab's research into reactive mineral phases using core samples preserved for redox integrity. A primary goal is to advance understanding of interfacial processes, the interaction between minerals and chlorinated solvents, and their impact on water quality and contaminant mobility and bioavailability. The Lab has been funded by the National Science Foundation, the U.S. Army, SUEZ North America, Chemours Company and the state transportation agencies of both New Jersey and New York.

Geo-Resources and Geotechnical Laboratory

Bruno M. Goncalves da Silva, Director

Broadly speaking, the research conducted at the Geo-Resources and Geotechnical Laboratory (GGL) aims to reduce the environmental impact and maximize the financial potential of geothermal, oil and gas production, as well as to better predict and mitigate geotechnical-related hazards triggered by natural or man-made causes, particularly related to the stability of rock slopes and underground openings. More specifically, the GGL investigates the multi-scale physical mechanisms responsible for the fracturing of rocks subject to various confinement stresses and hydraulic pressures, and focuses on fracture connectivity and micro-seismicity caused by hydraulic fracturing. Based on laboratory tests, our group develops theoretical and numerical models to simulate and interpret the fracturing mechanisms at the macro- and microscopic scales, ultimately elucidating the impact of these processes at the field scale.

Newark Design Collaborative

Anthony Schuman, Darius Sollohub and Georgeen Theodore, Co-Directors

The Newark Design Collaborative (NDC) at the Hillier College of Architecture and Design brings together NJIT faculty and students, city agencies, and community and industry stakeholders in the planning and design for an equitable, sustainable and prosperous city. The purpose of the collaborative is to engage community perspectives and contribute our collective expertise to Newark's development, while educating future designers and planners. We offer our students rich real-world learning through direct collaboration with the Newark community, providing them with the experiences needed to address the design challenges facing dense urban areas in the 21st century. The collaborative implements this mission through design studios, seminar classes, independent projects, reports and pro bono assistance. Through project documentation and the Digital Archive of Newark Architecture (DANA) in the Littman Library at Hillier College, the NDC serves as a resource for faculty, students, city agencies and developers. The long-term vision includes the establishment of a downtown facility for community engagement operated by Hillier College.

MATERIAL SCIENCE AND ENGINEERING

NJIT Center for Building Knowledge

Deane Evans, Director

The Center for Building Knowledge (CBK) is a 31-year-old research, training and technical assistance institute affiliated with the Hillier College of Architecture and Design. The Center is dedicated to generating new knowledge to improve the built environment and enhance the planning, design, construction and operation of facilities. CBK's mission is to help individuals and communities make better-informed decisions about the performance, sustainability and resilience of buildings and communities. The Center created and currently manages the New Jersey Clean Energy Learning Center, a unique online energy-efficiency training and resource platform for the New Jersey Clean Energy Program. CBK also manages and is currently updating a national online training platform funded by the U.S. Department of Energy (DOE) and focused on training building owners and operators on how to use the DOE's Asset Score energy optimization tool. The tool evaluates the energy efficiency of key physical assets within a facility – its building envelope, lighting and HVAC systems – and tabulates an "asset score." In addition, CBK recently received a three-year grant from the DOE's Building America program. The Re-Side Right project will test and validate a new, two-component insulation/air/water barrier system that can be used to significantly improve the energy efficiency of typical re-siding jobs in the U.S.

Electronic Imaging Center

Haim Grebel, Director

The Electronic Imaging Center is an interdisciplinary center focused on nanotechnology and spectral analysis with subwavelength structures and energy. Nanotechnology is a field dealing with phenomena at the nanoscale, including diverse phenomena that encompass molecular and biological interactions and interfacial science, as well as bulk and surface properties. The field is fast expanding into the agricultural, energy and pharmaceutical sectors. Spectroscopy with subwavelength structures is a field important to pollution detection, remote sensing and imaging at resolutions surpassing the diffraction limit. It is related to nanoscale phenomena, but can also find applications in the infrared and the THz frequency range. Energy is fast becoming a crucial commodity: its transmission, delivery and storage are key to the development of the U.S. economy and to the safeguarding of national security. Ongoing projects that focus on one or several aspects of the above include graphene-coated nano-optical antennas for molecular detection, tunable supercapacitors for energy storage, digital energy for efficient energy management and white light sources.

New Jersey Center for Engineered Particulates

Rajesh Davé, Director

The creation of advanced particulate materials and products through particle engineering is a major research focus of the New Jersey Center for Engineered Particulates (NJCEP). The Center's research combines experimental, computational and theoretical studies to achieve an understanding of particle properties at the individual particle scale to predict particle and product behavior at the macro-scale. NJCEP research has applications in the pharmaceutical, food, cosmetics, ceramics, defense, electronics and specialty chemicals industries. Center researchers have more than a dozen granted patents. An example of a noteworthy licensed technology is a solvent-free particle coating process with applications in taste-masking and the controlled release of drugs. NJCEP is funded by federal and industry sources, including through its participation in the National Science Foundation (NSF) – Engineering Research Center, which is focused on improving pharmaceutical manufacturing processes. NJCEP has developed several pharmaceutical technology platforms, including a thin stripfilm real-time release methodology, funded by NSF and the U.S. Food and Drug Administration, for delivering nano and micron-sized poorly water-soluble active ingredients for enhanced therapeutic effects. Currently, NJCEP is developing patient-compliant drug-delivery vehicles for pediatric and geriatric care, with commercial applications.

Center of Materials for Advanced Energetics

Edward Dreizin

Powders of metals are better fuels than hydrocarbons based on their volumetric and gravimetric combustion energy. They are used primarily in propellants, explosives and pyrotechnics. In this center, new metal-based reactive materials are developed, characterized and tested. Correlations between material synthesis processes and the powder characteristics are established and their reaction mechanisms are elucidated. The center includes laboratories for mechanochemistry and metal combustion and a state-of-the-art thermo-analytical facility. The center also conducts research in materials characterization facilities in York Center. Our work is supported by the Office of Naval Research, the Defense Threat Reduction Agency and the U.S. Army, among other sponsors. We invite students with backgrounds in chemical and mechanical engineering, physics, and materials science and engineering to explore research opportunities with us.

Membrane Science, Engineering and Technology Center

Kamalesh K. Sirkar, Director

The Membrane Science, Engineering and Technology Center, a National Science Foundation Industry/University Cooperative Research Center, conducts basic research and related development on innovative materials and processes that facilitate the use of membrane technology. The center also provides timely and effective technology transfers between the center's researchers and its sponsors, from private industry and U.S. government laboratories. With the research preformed primarily by graduate students, the center promotes education in membrane science and technology. The research topics are decided by corporate members of the Industrial Advisory Board. This center is located at four university research sites: NJIT, Pennsylvania State University, the University of Colorado at Boulder and the University of Arkansas at Fayetteville. NJIT faculty members from the following departments are active in the center: chemical and materials engineering; chemistry and environmental science; civil and environmental engineering; biomedical engineering; and electrical and computer engineering.

Center for Membrane Technologies

Kamalesh K. Sirkar and Boris Khusid, Co-Directors

The Center for Membrane Technologies investigates problems across multiple industrial sectors that use membrane technologies to separate and purify water, air, industrial-fluid streams, solvents, pharmaceuticals, proteins, biopharmaceuticals, cells, particles and nanoparticles. Membrane synthesis, membrane modification and the development of novel membrane-based separation techniques are of particular interest. The problems we are researching include solvent-resistant nanofiltration with pharmaceutical applications, the separation of organic solvent mixtures by a membrane, continuous production of nanocrystals via hollow-fiber membranes and the development of ultrathin membranes for use in gas separation. The organic synthesis of drugs involves many steps requiring frequent exchanges of solvents, recovery of catalysts, concentration of active pharmaceutical ingredients and their final purification by crystallization. Nanofiltration membranes capable of resisting solvents are of great value for such operations, as they allow solvents to pass through while retaining solutes with greater molecular weights. We are studying the behavior of novel, inert polymeric membranes for nanofiltration that permit solvent flow, but reject the solutes. We are also investigating the possibility of separating organic solvent mixtures by a membrane. We have already succeeded in obtaining a pure solvent in permeate from a few varieties of binary solvent mixtures which is unprecedented in membrane separations. We are also exploring novel techniques for making ultrathin films with considerable separation potential for various gas separations, such as carbon capture from power plant emissions.

Center for Natural Resources

Michel Boufadel, Director

The Center for Natural Resources investigates practical and efficient approaches to environmental and energy resource utilization. Research projects include assessment and remediation studies of pollution in natural settings and the evaluation of natural resources for the potential production of energy, especially renewable energy. Current projects include determining the trajectory of the underwater oil plume in the Gulf of Mexico and evaluating remediation techniques for oil spills, including using microorganisms to break down the oil. Projects have also been initiated to study the impact of oil releases in high salinity (brine) pools, commonly encountered at depths exceeding a mile in the ocean and the Gulf of Mexico. Little is known to date about the effect of high-salinity water on the behavior of either oil or spill countermeasures, such as applied dispersants.

NJIT Center for Resilient Design

Deane Evans, Director

The Center for Resilient Design (CRD) is a seven-year-old research, training and technical assistance institute affiliated with the Hillier College of Architecture and Design. Established in the immediate aftermath of Super Storm Sandy, CRD's founding mission was to serve as a resource to help New Jersey communities recover from the effects of Sandy – first as a special program within the College of Architecture and Design (COAD) and then as a full-fledged center within the university. These activities soon evolved into broader explorations of how these same communities could become more resilient in the face of future events. Building on lessons learned in New Jersey, the Center has become a research, technical assistance and training institution focused on improving the resilience of buildings and communities in the face of natural disasters and other stresses to inform and support disaster-resilience initiatives in other jurisdictions across the U.S. and beyond. CRD recently completed and launched a new, online educational platform – the Community Microgrids Planning Academy – to help jurisdictions across New Jersey create microgrid development plans to improve the energy performance and resilience of their communities. The project – funded by the U.S. Department of Housing and Urban Development and managed by the N.J. Department of Community Affairs – was designed to constitute the first component of a comprehensive educational program that addresses first the planning and then the technical feasibility and financing/procurement phases of a microgrid development project. Funding for these activities has recently been secured from the New Jersey Clean Energy Program for the technical feasibility module and from the U.S. Department of Energy (through the New Jersey Board of Public Utilities) for the financing/procurement module. The Planning Academy also received a prestigious Award of Merit for "Innovations for High-Performance Buildings and Communities" from the National Institute of Building Sciences' 2018 Beyond Green Awards program.

Additive Manufacturing Laboratory

John Federici and Ian Gatley, Co-Directors

The Additive Manufacturing Laboratory (AddLab) specializes in innovations using modern additive manufacturing techniques, including 2D and 3D printing in conjunction with embedded electronics. Additive manufacturing has revolutionized manufacturing production, bringing down the cost of prototyping, while allowing for novel designs and devices never before possible. In-situ, non-destructive evaluation methodologies that monitor the fabrication process and efficiently qualify fabricated components are under development. The AddLab works with industrial partners to transition research and development from the laboratory into industrial scale production. Our extensive 2D and 3D fabrication tools, in combination with expertise with simulations and modeling, enables the lab to develop and optimize manufacturable components for U.S. Department of Defense customers as well. The AddLab faculty, staff and students take pride in developing the workforce of the future. Many opportunities are available for undergraduate internships during the academic year and over the summer, as well as graduate student research.

Applied Electrohydrodynamics Laboratory

Boris Khusid, Director

The Applied Electrohydrodynamics Laboratory explores electric and magnetic field-driven phenomena in suspensions, which are mixtures of solid particles and a liquid. Suspensions are a ubiquitous feature of our daily environment — paints, blood, milk, inks — while they are also utilized in a wide variety of industries. Ongoing projects in the lab focus on understanding how the electric and magnetic interactions between particles affect their arrangement, and thereby, their suspension properties. Practical applications are related to the development of electro-magnetic methods utilizing a difference in polarizability between suspended particles and a suspending liquid for the precise manipulation, separation and sorting of particles in suspensions. These methods do not require moving parts and employ an electrical or magnetic force acting on a particle that is insensitive to the particle charge, which is difficult to control.

Biophotonics and Bioimaging Laboratory

Kevin D. Belfield and Yuanwei Zhang, Co-Directors

The Biophotonics and Bioimaging Laboratory combines diverse chemical and biological approaches to develop novel biomaterials and techniques to explore and sense pathological processes. The lab investigates fundamental principles and develops new methods for the interaction of light with biological organisms, tissues, cells and molecules, an area that is regarded as key science for the next generation of clinical tools and biomedical research instruments. We develop novel organic linear and nonlinear optical probes and bioconjugates that can be used to detect subcellular events and for deep tissue in vivo imaging via fluorescence microscopy and light-activated drug delivery and photodynamic therapy. We collaborate with other scientists and clinicians to optimize and apply these technologies to solve problems in biological and biomedical research. Early disease detection and subsequent treatment, viewed as central to disease management, require technologies that combine sensing, targeting and treating. To achieve this goal, the lab develops fluorescent probes for two-photon-based deep tissue tumor and angiogenesis imaging for cancer diagnosis and imaging-guided surgery, as one example. Functional organic, polymer, inorganic and hybrid nanoparticles are central to our efforts in the development of sensors, photoactive medicines, and materials for emerging quantum data computing.

Biophotonics Sensing and Imaging Laboratory

Xuan Liu, Director

The Biophotonics Sensing and Imaging Laboratory investigates advanced biophotonics technologies with a focus on optical coherence tomography (OCT). We have in-house capabilities to develop novel optical imaging systems for a variety of applications, including the design of optical imaging systems, optical component alignment, algorithm development and real-time signal processing. In one of our funded research projects, we investigate dual-modality OCT imaging that performs structural and mechanical characterization of breast tissue to achieve higher accuracy in breast cancer diagnoses. We also collaborate with industrial partners to develop OCT sensor-guided surgical instruments and an ultrafast 3D imaging technology.

Complex Flows and Soft Matter Group

Linda Cummings, Lou Kondic, Anand Oza (Directors)

The focus of the Complex Flows and Soft Matter Group is on fluid systems that are complex due to rheological properties, complicated flow geometry, complex multiphysics aspects of the forces governing the flows, or a combination of these factors. We carry out modeling and simulations of such problems, as well as developing appropriate computational methods. Current projects include mathematical modeling and simulation of membrane filtration, schooling and flocking models (for fish and bird locomotion), "quantum" behavior of walking droplets, flow of granular media, and wetting and de-wetting of thin liquid films under the action of a range of external forces. In some cases, we also carry out physical experiments in our Undergraduate Capstone Laboratory in coordination with the capstone course taken by our applied mathematics majors. Our work, in which we collaborate with scientists from a number of different institutions, is supported by the Center for Applied Mathematics and Statistics, the Department of Mathematical Sciences, and by grants from a number of federal research agencies. See cfsm.njit.edu.

Computational Biophysics Laboratory

Cristiano Dias, Director

Research in the Computational Biophysics Laboratory concentrates on the development of computational tools to answer complex questions at the interface of physics, biology and chemistry for medical and industrial purposes. We focus on three areas: designing new biomaterials with superior properties emerging from the aggregation of proteins into fibril-like structures that are biodegradable and biocompatible; investigating the cell toxicity of amyloid proteins responsible for degenerative diseases like Alzheimer's and Parkinson's; and predicting the effect of solvents on protein and lipid membrane structures. We use multiscale approaches to provide atomic resolution of macroscopic structures in order to understand and control systems, by self-organization or by design, from nanometer to mesoscopic scales. Experimental methods used to validate our simulations include, but are not limited to, cell and single-molecule imaging techniques.

Computational Laboratory for Porous Materials

Gennady Gor, Director

The main focus of the Computational Laboratory for Porous Materials is nanoporous materials, solids with pores of 100 nanometers and below. Such materials play a significant role in both nature and technology. Synthetic nanoporous materials are widely used in the chemical industry as adsorbents, catalysts and separation membranes, among other uses. Naturally occurring nanoporous materials include coal and shale, key fuels in the production of energy. Another research focus is soot agglomerates, which are not porous, but rather nanostructured materials with features on the same scale as nanoporous solids. We work on the wide spectrum of phenomena related to the interfaces between these nanoporous or nanostructured solids and fluids: fluids adsorption, fluids transport and the propagation of ultrasound in fluid-saturated porous media, to name a few. Our approaches are purely theoretical; we use various modeling techniques to represent phenomena at the nanoscale: Monte Carlo simulations, molecular dynamics, density functional theory and finite element analysis.

Computational Nanomechanics and Materials Science Laboratory

Dibakar Datta, Director

The Computational Nanomechanics and Materials Science Laboratory (CNMSL) promulgates a fundamental understanding at the atomic and molecular level of the chemical-electrical-mechanical phenomena of nanomaterials used for real-life applications such as energy storage devices (rechargeable batteries, fuel cells), electronic devices (smartphones, laptops) and healthcare (targeted drug delivery, medical nanodevices), among other areas. The Lab investigates various nanomaterials, including crystalline solids such as silicon and germanium; atomically thin two-dimensional materials such as graphene and transition metal dichalcogenides; and their heterostructures, which include the combination of different nanomaterials. Novel theories and methodologies are developed for modeling the interplay between mechanical, electronic, thermodynamic and kinetic aspects of nanostructures. The computational results provide the guidelines for the experimentalists for the most efficient experimental design of nanomaterials-based structures that are used in everyday life.

Computer-Assisted Tissue Engineering and Blood System Biology Laboratory

Roman Voronov, Director

The Computer-Assisted Tissue Engineering and Blood System Biology Laboratory focuses on high-performance, image-based modeling of complex flows with applications ranging from bone tissue engineering, to blood systems biology, to drug delivery. The lab is currently involved in two major projects. First, we are developing computer-assisted tissue engineering technologies through predictive modeling of stem cell behavior and the control of single-cell migration. Second, we are looking closely at the mechanisms of blood clot formation, which is relevant to thrombotic disorders such as strokes, heart attacks and hemophilia. The tools used for this work involve soft lithography, hardware automation, superresolution microscopy, computer vision and machine learning.

Heat and Fluid Transport Engineering Research Laboratory

Angelantonio Tafuni, Director

The mission of the Heat and Fluid Transport Engineering Research (HaFTER) Laboratory is to investigate state-of-the-art problems in the field of fluid mechanics and heat transfer within complex engineering systems. Problems of interest include multiphase flow and fluid-structure interactions in aerospace and ocean engineering applications, free-surface flow in river and coastal environments, and the optimization of industrial processes involving fluid dynamics. Computational fluid dynamics techniques are developed and validated to address challenging problems in engineering. These include threedimensional highly nonlinear flow with one or more phases, such as the bubbly flow and spray generated by ships. The laboratory is also home to a mechanical platform for the experimental investigation of various liquid sloshing phenomena.

High-Performance Concrete and Structures Laboratory

Methi Wecharatana, Director

Critical innovations in the area of high-performance concrete in recent years include the development of highly durable concrete, impact-resistant concrete, microdefect-free concrete, fiber-reinforced concrete, fly-ash concrete, highperformance carbon fiberreinforced concrete and high-strength fiber-reinforced plastics, among others. With funding from the National Science Foundation (NSF), we have installed six closed-loop hydraulic MTS and Instron testing machines with capacity ranging from 25,000 to 1 million pounds in our state-of-the-art laboratory and testing facility. In our highbay structural concrete lab, we test full-scale, 12-footlong columns with automated closed-loop hydraulic testing machines; our reaction walls enable us to simulate lateral loads from both wind and earthquakes. Past and ongoing funding for our research comes from government agencies such as the NSF, the U.S. Department of Energy and the National Oceanic and Atmospheric Administration, as well as from private partners such as Public Service Electric and Gas and SCG of Thailand.

Instructive Biomaterials and Additive Manufacturing Laboratory

Murat Guvendiren, Director

The Instructive Biomaterials and Additive Manufacturing Laboratory (IBAM-Lab) develops novel biodegradable polymers and hydrogels and fabricates biomaterials, medical devices and tissue-engineered organs using additive manufacturing. Despite significant efforts, the lack of organs and tissue for transplantation poses a major hurdle in medicine. We take a multidisciplinary approach toward developing innovative treatment alternatives using novel biomaterials with 3D-bioprinting. The IBAM-Lab develops biodegradable polymers and hydrogels with user-defined and tunable processability, mechanics, degradation and functionalizability; engineers medical devices, tissues and organs using 3D-bioprinting; develops material-based technologies to control stem cell differentiation; and fabricates patient-specific in vitro disease models for fundamental studies and drug screening. Additionally, the IBAM-Lab devises novel strategies for biomimetic material design, stimuli-responsive materials, surface patterning and photopolymerization, in which light turns liquids into gels in our lab. Our facilities include a wet lab designed for polymer discovery, synthesis and processing, and a biolab for elucidating cell-material interactions in vitro. Additive manufacturing capabilities offer extrusion-based printing technologies and vat photopolymerization printing

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Mass Spectrometry Center

Hao Chen, Director

Mass spectrometry (MS) is a fascinating technology with a growing impact on chemical measurement and imaging for a variety of areas, such as analytical chemistry, environmental chemistry, forensic chemistry and life science research. Our passion for the topic encompasses many different MS areas. The Mass Spectrometry Center focuses on using MS to study proteomics (the analysis of sets of expressed proteins), electrochemistry, organic chemistry, environmental science and forensic chemistry. In one of our projects, we combine electrochemistry (EC) and MS to elucidate disulfide bond-containing protein sequences and protein conformational structures. In particular, the combined EC/MS can be used for absolute quantitation of proteins/peptides and drug impurities where standards are difficult, expensive to obtain or not available. Our lab collaborates extensively with both academic and industrial partners.

Material Analysis in Biological Systems Laboratory

Kathleen McEnnis, Director

The Material Analysis in Biological Systems Laboratory investigates the interaction of polymer drug delivery vehicles with the biological environment, including cells, blood, proteins and physiological temperature, using physical chemistry techniques in novel ways to design successful particles for drug delivery. Drug delivery vehicles are an ideal treatment for many diseases. In practice, however, their design is challenging, and few are currently used clinically. The interaction of the biological environment with drug delivery vehicles is not well understood, and by addressing this gap, better and more successful models can be designed. The Materials Analysis in Biological Systems Laboratory investigates novel techniques to analyze nanoparticles in blood, nanoparticle aggregation and protein corona formation in blood, particle glass transition temperature in biological conditions and the cellular uptake of particles.

Materials and Structures Laboratory

Matthew P. Adams and Matthew J. Bandelt, Co-Directors

The Materials and Structures Laboratory (MatSLab) is a research center focused on improving the knowledge base of materials and structures in the built environment and reengineering them for the future. The laboratory consists of experimental and computational facilities capable of evaluating the performance of existing and emerging construction materials and structures from the nanometer to the meter scale. Recent research has focused on the behavior of sustainable materials, such as recycled concrete aggregates (RCA), and resilient and damage-tolerant materials, such as high-performance fiber-reinforced concrete (HPFRC). Recent laboratory upgrades allow for testing, characterization and modeling of other sustainable and resilient materials and structures. RCA materials are being used in pavement design, such as for the Illinois Tollway, to increase sustainability and reduce cost; HPFRCs are being deployed in bridge structures, such as the Pulaski Skyway Project, to decrease construction time, and in earthquake-resistant buildings, such as the Lincoln Square Expansion in Bellevue, Washington, to increase ductility and damage tolerance. Recent research at the MatSLab has been funded by the Federal Highway Administration, the U.S. Department of Transportation's University Transportation Center, the New Jersey Department of Transportation and the American Concrete Institute.

Material Dynamics Lab

Martina Decker, Director

The Material Dynamics Lab was founded in 2008 to create a research space for faculty, students and industry members from the fields of architecture and biomedical engineering. Since 2012, the interdisciplinary research hub has expanded upon the collaborative mission and now additionally fosters relationships among team members from numerous areas: the Department of Physics; the Department of Mechanical and Industrial Engineering; the Department of Chemistry and Environmental Science; the Department of Biology; the Department of Civil and Environmental Engineering; the Department of Electrical and Computer Engineering; and the Department of Computer Science. The Material Dynamics Lab serves as a vital junction for interdisciplinary innovation and undergraduate research through the application of the design thinking methodology. Projects that emerge from the lab are as diverse as its collaborators. They include the reconstruction of prehistoric "hell ants"; the fabrication of a collaborative robotic fleet of sensor bots; smart material-driven building "skins" for environmental control; and a multispectral camera that takes laboratory-bound tabletop inventions to a handheld design stage that can be tested in the field.

Mixing Laboratory

Piero M. Armenante, Director

The Mixing Laboratory is dedicated to the study of single- and multi-phase mixing phenomena, such as those occurring in industrial stirred tanks and reactors, involving single fluids – primarily liquids with different rheological properties – in the presence or absence of one or more additional phases, such as fine solid particles, a dispersed gas or an immiscible liquid. Mixing phenomena are extremely common in industry, taking place in very small systems, such as tablet dissolution in testing units used in the pharmaceutical industry, and in large production units, such as drug solid suspensions in a carrier liquid for pharmaceutical product manufacturing. The outcome in each case is significantly affected by the hydrodynamics established by a moving component, typically an impeller. Understanding the fluid dynamic characteristics of these systems is critical. For this purpose, the Lab is equipped with state-of-the-art equipment, such as particle image velocimetry, to non-intrusively measure the fluid velocities anywhere in the system. Additionally, numerical tools, including computational fluid dynamics and theoretical process modeling, such as mass transfer models, are used to determine how mixing affects processes of real industrial interest – often in collaboration with industrial partners – and how it can be modified to improve outcomes.

Laboratory for the Mechanics of Advanced Materials

Shawn A. Chester, Director

The primary research goal of the Laboratory for the Mechanics of Advanced Materials is to understand interesting and exciting phenomena in solid mechanics, particularly multiphysics material behavior. Multiphysics behavior occurs when multiple physical phenomena are present in a material's response, beyond deformation. For example, temperature can have a profound impact on the stiffness of materials and some oils degrade the strength of a material over time. Research includes experimental, theoretical and computational solid mechanics. The Laboratory works on continuumlevel descriptions of polymeric behavior of materials, including polymer gels, dielectric elastomers and shape-memory polymers, among others. The Lab's general procedure is to conduct experiments to obtain a material's behavior over a wide range of environmental conditions; to develop constitutive models to capture that behavior; to design and implement numerical procedures for use in finite element simulations; and lastly, to validate the constitutive model and its numerical implementation in exciting representative applications.

Micro and Nano Laboratory

Sagnik Basuray, Director

The Micro and Nano Laboratory establishes synergies among novel nanostructures, microfluidics, biology, materials chemistry and electrokinetics in order to develop disruptive new technologies in sensors, diagnostics, drug delivery systems and biofilms that use cost-effective tools. Among other aims, the lab advances knowledge of interfaces and surface physics. Current research includes the development of a modular, adaptive, electrochemical biosensor platform (ESSENCE) that meets the "ASSURED" criteria set by the World Health Organization for point-of-care (POC) devices used, for example, to detect bio-threats, infectious diseases and pollutants. In collaboration with the Pacific Northwest National Lab, a point-of-use sensor has been developed for the detection of PFAS (per- and polyfluoroalkyl substances), which are industrial pollutants. The Micro and Nano Laboratory is working with researchers and companies on developing new technologies for batteries, supercapacitors, electrical field-assisted separations, biologics and electro-catalysts. Our facilities include a wet lab set up for the design, development and testing of microfluidics, cell work using lab-on-a-chip devices and electrochemical characterization.

Nanoelectronics and Energy Conversion Laboratory

Dong-Kyun Ko, Director

The Nanoelectronics and Energy Conversion Laboratory is an interdisciplinary research group that studies nanoelectronic devices made from colloidal quantum dots (QDs). Colloidal QDs are nanometer-sized semiconductor crystals suspended in a solution that offer exciting opportunities for scientists and engineers to develop ultra-cheap, pervasive devices for the emerging ubiquitous electronics era, in which electronic devices are embedded into many of the objects we touch and the environments we live in. One of our principal goals is the development of QD sensors that can detect thermal infrared, or heat. Our aim is to reduce the size, weight and power consumption of these devices to enable their wide-spread utilization in first-responder and search-and-rescue missions, night driving, machine vision, industrial process controls, environmental monitoring of hazardous spills and non-invasive measurements of tumors and blood flow, as well as in optical communications. Other projects include the development of thermoelectric QDs that can produce electrical power directly from waste heat, which is widely available in both natural and man-made environments. The goal is to scavenge energy from the environment to continuously power embedded electronics devices, ultimately enabling them to achieve power autonomy.

Nanomaterials for Energy and Environment Laboratory

Xianqin Wang, Director

The goals of the Nanomaterials for Energy and Environment Laboratory (NEEL) are to develop advanced functional nanomaterials for sustainable energy production and environmental protection, and to investigate the structure and reactivity of catalytic systems under operational conditions such as high pressure and temperature. Research topics include, but are not limited to: hydrogen production from bio-alcohols on a series of transition metal oxide nanoparticles; bioalcohols or biofuel production from biomass over novel catalytic materials; completely green catalytic materials for solar water splitting and oxygen reduction reactions; fuels production and purification for solid-oxide fuel cells and proton-exchange fuel cells, among others; water treatment with catalytic nanoparticles encapsulated in a hierarchical framework; nitrogen and sulfur removal from crude oil and other organics; structural and electronic properties of various materials using synchrotron-based in situ time-resolved techniques, such as catalytic, pharmaceutical and energetic materials. Our aim is to contribute to a cleaner, healthier environment for current and future generations.

Laboratory of Nanomedicine and Healthcare Biomaterials

Xiaoyang Xu, Director

The Laboratory of Nanomedicine and Healthcare Biomaterials aims to develop new biomaterials and nanotechnologies for a variety of medical applications, including diagnosis, bioimaging, controlled drug delivery and regenerative medicine. We look at both fundamental and applied questions in the cross-disciplinary fields of biomaterials, nanomaterials and medicine in order to develop novel therapeutic methods for the treatment of cancer, obesity, cardiovascular disease and many other conditions and diseases. One specific goal is to develop multifunctional nanoparticles for medical applications, including drug-delivery mechanisms and regenerative medicine, such as the development of targeted nanoparticles to deliver therapies to the brain. We are also developing mRNA-based nanoparticle vaccines to protect against COVID-19. Another major area of focus is the development of synthetic biomaterials and processing techniques to fabricate hydrogels and scaffolds with degradable and biocompatible properties for use in drug delivery and tissue engineering.

Nano-Optoelectronic Materials and Devices Laboratory

Hieu P. Nguyen, Director

The Nano-Optoelectronic Materials and Devices Laboratory develops high-performance nanophotonic and nanoelectronic devices for lighting and energy storage applications. Such devices are fabricated from gallium nitride (III-nitride)-based semiconductors in the form of nanostructures devised through a state-of-the-art epitaxial growth technique called molecular beam epitaxy. III-nitride nanostructures have emerged as a powerful platform to effectively scale down the dimensions of future devices and systems. The research group aims to develop superior quality III--nitride nanostructures wherein we will investigate their epitaxial growth, characterization and applications. We believe this will provide an enhanced materials system and device structure for applications in biological sensors, solid-state lighting, digital displays, electronic textiles, water purification systems and solar cells, as well as hydrogen generation and carbon-dioxide reduction for clean, storable and renewable sources of energy.

Laboratory for Numerical Turbulence

Simone Marras, Director

The Laboratory for Numerical Turbulence aims to understand the ties between the numerical approximation of the equations of fluid dynamics and the physical parameterization of the sub-grid scale mechanisms at the core of turbulence. Specifically, the lab concentrates on the development of efficient algorithms for the direct and large-eddy simulation of turbulence with the goal of minimizing the numerical error introduced by the discretization of governing equations onto the modeling of the sub-grid scale mechanisms. Our research is used in the fields of atmospheric turbulence, aeroacoustics and aerodynamics, among other areas of engineering and science; applications range from managing turbulence in free surface flows to the aeroacoustics of wind turbines and large wind farms in the atmospheric boundary layer.

Organic Reactions and Mechanisms Laboratory

Pier Alexandre Champagne, Director

The Organic Reactions and Mechanisms Laboratory focuses on the development of novel approaches toward organic molecules and the study of how chemical reactions happen at the molecular level. To this end, we combine experimental and computational tools to invent, understand and improve transformations for organic synthesis. Our research focuses on two main areas related to the synthesis of complex molecules targeted for pharmaceutical research. Ongoing projects include the synthesis of complex alkanes, which are useful in cancer treatment, using boron-containing reagents; the valorization of sulfur for the synthesis of medicinally-relevant heterocycles, a class of organic chemical compounds; the investigation of organic mechanisms using physical organic chemistry tools; and the study of important catalyzed reactions using theoretical calculations based on density functional theory.

Particle Engineering and Pharmaceutical Nanotechnology Laboratory

Ecevit Bilgili

The Particle Engineering and Pharmaceutical Nanotechnology Laboratory (PEPNAL) designs advanced particulate formulations and processes for various high-value-added product industries such as the pharmaceutical, flavors and fragrances, nutraceuticals and agrochemical industries. With an array of characterization and processing equipment, the laboratory has made significant advances on the bioavailability enhancement of poorly water-soluble drugs via three platform approaches: nanosuspensions, nanocomposites and amorphous solid dispersions. Highlights from recent research include the preparation of sterile-filterable drug nanosuspensions for long-acting injectable drugs, fast-dissolving surfactant-free drug nanocomposites with colloidal superdisintegrants for bioavailability enhancement, and hybrid nanocrystal–amorphous solid dispersions for enhanced drug solubilization. The laboratory also examines mechanisms such as particle breakage, aggregation and growth during the formation of nanoparticles and microparticles. We couple experimentation with population balance modeling, discrete element modeling and computational fluid dynamics to elucidate complex non-linear rate processes that occur in pharmaceutical manufacturing operations. The laboratory has secured funding from the National Science Foundation, the Food and Drug Administration and various private companies.

Soft Matter Research Laboratory

David C. Venerus, Director

The focus of the Soft Matter Research Laboratory is the characterization of soft matter, such as synthetic polymers, biomaterials, gels, foams and emulsions, with the goal of establishing relationships between microstructure and material properties. The experiments carried out in the lab advance development of new processes and materials for applications ranging from plastics packaging to biomedical devices. The laboratory includes both commercial and custom-made instruments to perform novel rheological experiments in both shear and elongational flows. Also included in the laboratory is a custom-made optics setup that allows for novel light scattering to investigate non-classical thermal and mass transport in soft matter.

Sustainable Environmental Nanotechnology and Nanointerfaces Laboratory

Wen Zhang, Director

In the Sustainable Environmental Nanotechnology and Nanointerfaces Laboratory, we integrate concepts and principles of nanotechnology and sustainability into environmental engineering research and education. Our research is mainly focused on: material characterization at nanoscale using hybrid atomic force microscopy; environmental behavior and interfacial processes for nanomaterials and nanobubbles; novel catalytic processes for harnessing renewable energy and pollutant degradation; and reactive membrane filtration systems. In the investigations of nanomaterial interfaces, the laboratory specializes in performing in situ measurements of multiple materials' properties using a combination of atomic force microscopy (AFM), Raman spectroscopy, infrared spectroscopy and scanning electrochemical microscopy. Material properties that could be acquired at a local or nanoscale include morphology, surface potential, electronic structures, hydrophobicity, chemical compositions, distribution and electrochemical activities. Holistic and accurate measurements of these properties are critical for devising functional nanomaterials and devices in catalysis, fuel cells, nanomedicine, drug delivery, pollution treatment and remediation.

Terahertz Spectroscopy, Imaging and Wireless Communication Laboratory

John Federici and Ian Gatley, Co-Directors

The Terahertz Spectroscopy, Imaging, and Wireless Communication (THz SPICE) Laboratory specializes in the development and application of terahertz (THz) technology to spectroscopy, imaging and wireless communication. The THz frequency ranges from about 0.1-3 THz corresponds to the far-infrared spectral range. The laboratory's research in spectroscopy and imaging focuses on the non-destructive evaluation of materials, including THz Computed Tomography, additively manufactured components and plastic welding. The laboratory has expertise in terahertz wireless communication. Research efforts include evaluating the effects of atmospheric weather on THz communications as well as THz reflectors and antenna arrays for indoor THz communications.

Tissue Engineering and Applied Biomaterials Laboratory

Treena Livingston Arinzeh, Director

The Tissue Engineering and Applied Biomaterials Laboratory develops functional biomaterials for regenerative medicine applications. Recent discoveries in the tissue-engineering field have shown that the microenvironment can influence stem cell self-renewal and differentiation, which has had a tremendous impact on identifying potential strategies for using these cells effectively in the body. This laboratory develops functional biomaterials that impart cues to stem cells, either already present within the body or implanted, to affect their behavior. These biological cues stimulate growth in bone and spinal cord tissue, for example. Our laboratory has pioneered the use of bioactive ceramics and composites for use in bone-tissue engineering. Novel bioinspired materials such as glycosaminoglycan (GAG) mimetics and piezoelectric materials also are being developed for bone, cartilage and neural applications. GAG mimetics combine with growth factors to stimulate tissue growth and piezoelectric materials provide electrical stimulation to cells. Current funding is from federal, state and private agencies.

Tissue Innervation and Muscle Mimetics Laboratory

Jonathan Grasman, Director

The Tissue Innervation and Muscle Mimetics Laboratory develops biomaterials and tissue-engineered strategies to understand the mechanisms and processes by which tissue innervation occurs, and how to leverage these data to improve skeletal muscle repair outcomes. Neural and vascular networks are critical components of each of the tissues within our bodies, and yet many tissue engineering strategies rely on their passive incorporation into nascent tissue. In fact, the failure to generate both of these structures is a significant limitation in regenerative medicine, especially in skeletal muscle, which has a high density of both of these structures to maintain proper function. Specifically, we focus on fabricating tissue systems from a variety of biopolymers to generate neurovascular and skeletal muscle tissue mimetics to enhance regeneration and innervation in incidents of traumatic injury, neuropathy and genetic disorders both in in vitro and in vivo.

ROBOTICS AND MACHINE INTELLIGENCE

Intelligent Transportation Systems Resource Center

Lazar Spasovic, Director

The Intelligent Transportation Systems Resource Center (ITS) was established as a research and technology resource for the New Jersey Department of Transportation's Division of Traffic Operations and Division of Mobility and Systems Engineering. ITS utilizes roadside sensing, information and communication technologies and integrates them into traffic engineering and management practices with the goal of reducing congestion and improving the mobility, safety and efficiency of the transportation system in support of sustainable regional growth and economic development. The main purpose of the center is to conduct research studies of innovative ITS technologies and optimize strategies for their deployment in the regional transportation system. This is accomplished through technology assessment, the evaluation of strategies and deployment scenarios, concept-development studies and technology transfer and training. The center and its laboratory also serve as a test bed for innovative and promising new ITS technologies. They include vehicle sensing and traffic-flow monitoring, automated traffic-incident detection and emergency response, active traffic management using traffic sensors and wireless communication, traffic and transportation data analytics, ITS system integration, and the introduction of connected and autonomous (driverless) vehicle technologies on our roadways. From a teaching and learning standpoint, the center builds on and further strengthens NJIT's competencies and national stature in the research areas of information and communication technology and sustainable systems and infrastructure. The center also serves as the nexus among federal and state transportation agencies, the regional academic research community and the private sector engaged in the development and implementation of innovative transportation-intelligence technology and services.

Center for Rehabilitation Robotics

Sergei Adamovich, Director

The Center for Rehabilitation Robotics is comprised of multiple projects applying robotics, virtual reality, brain imaging and non-invasive brain stimulation to improve the lives of individuals with disabilities. The largest of these, funded by the National Institutes of Health, employs a unique combination of robotics and virtual reality for neurorehabilitation of people with limited arm capability resulting from a recent stroke. Five smaller projects on wearable robots, supported by a multi-year grant from the National Institute on Disability, Independent Living, and Rehabilitation Research, address lower-extremity exoskeletons to restore walking in individuals with stroke; use epidural electrical stimulation to increase spinal cord transmission and improve the use of exoskeletons by people with spinal cord injury; and research new robotic technology for stroke therapy to be used in the home. In two development projects, Center researchers are designing new human-robot interfaces allowing people to control exoskeletons in a biologically natural way. The Kessler Foundation and the Department of Rehabilitation and Movement Science at Rutgers University are major collaborators.

AI for Social Good Lab

Hai Phan, Director

The AI for Social Good Lab (AI4G) focuses on diverse applications involving AI, big data and machine learning. They include exploring novel techniques that advance privacy, security and trustworthiness in AI and machine learning; the application of AI for social good in areas such as health informatics, human sensing and modeling, and network analysis; and transferring technology for practical applications through industry partners. Projects include drug-abuse monitoring on social networks and modeling human behaviors and mental health during the COVID-19 pandemic using a machine learning technique called Federated Learning on smart phones. We are currently building a mobile app to monitor students' mental and physical wellness. The AI4G Lab has long been committed to broadening participation in computing and education. The lab is supported by research funding agencies and industry partners, including the National Science Foundation, Wells Fargo, Qualcomm and Adobe.

Assistive and Intelligent Robotics Laboratory

Lu Lu, Director

The Assistive and Intelligent Robotics Laboratory conducts research on robotic theory and applications that help people in need and benefit society in various ways. There are two primary research areas: assistive robotics and intelligent unmanned aerial vehicle (UAV) systems. The assistive robotics research aims to help individuals with daily activities at home using advanced human-robot interaction techniques. The UAV research develops new types of drones and drone systems capable of dexterous locomotion and manipulation in the air, which can be applied to a variety of practical applications such as automated infrastructure maintenance, construction and decoration, and subterranean mapping and investigation.

Automation and Robotics Laboratory

Cong Wang, Director

The Controls, Automation and Robotics Laboratory (CAR) focuses on the development of control theories and their applications to automation and robotics. With a strong tie to the community of dynamic systems and controls, we continue to push frontiers in the field, especially in the direction of machine learning-based methods and data-oriented and statistical methods. We emphasize the use of computational intelligence and data science. Our work enables us to develop advanced automation and robotics technologies. In particular, we are challenging the limits of high-performance control for advanced manufacturing and automation, as well as developing intelligent and ultra-high-maneuverability motion systems for human-robot interactive and collaborative operations and extreme robotic manipulations. This technology is targeted at sectors ranging from advanced manufacturing, to household automation, to healthcare.

Face Recognition and Video Processing Laboratory

Chengjun Liu, Director

The Face Recognition and Video Processing Laboratory investigates advanced pattern recognition and video analytics methods and develops novel technologies to solve challenging problems, such as automated traffic incident detection and monitoring, facial recognition, image search, video retrieval, big-data analytics and visualization. Our video analytics system, which achieves next to a one order of magnitude improvement over RADAR for vehicle counting, has outperformed commercial systems for automated traffic incident detection and monitoring in challenging environments. Our facial recognition technology is able to reliably verify face images at a very low false-accept rate. Our patented face detection technology, iris detection and recognition technologies, and image-search technologies are additional focuses of the lab's research and development work.

Information Ecosystems Lab

Cody Buntain, Director

The Information Ecosystems (InfEco) Lab studies how individuals engage on social media and the effects on the broader information ecosystem. Research carried out at the InfEco Lab centers on three areas: developing technology to make this online environment more informative, especially during crises and disruption; studying factors of information quality and methods to reduce misinformation and bias; and building online spaces that are more resilient to disinformation and manipulation. Recent journal publications include a Science Advances article on automated methods for detecting misinformation campaigns, an article on cross-platform, quality-improving effects of YouTube's recommendation systems, and the identification of relevant and critical social media content during the COVID-19 pandemic. This research has received international coverage by the Washington Post, WIRED, Business Insider and NBC New York, among other sources.

Intelligent Transportation Systems Laboratory

Jo Young Lee, Director

The Intelligent Transportation Systems Laboratory (ITSL) is a multidisciplinary research hub for the development and deployment of cutting-edge ITS and connected and automated vehicles (CAV) technologies to improve the mobility, safety and environmental performance of the transportation system. Among other devices, the Lab houses traffic signal controllers, traffic sensors that employ radar, Bluetooth/WiFi and lidar, dedicated short range communications (DSRC) devices, microscopic traffic simulation tools and a high-fidelity driving simulator. The Lab also operates two connected and automated transport (CAT) vehicles. Equipped with a DSRC on-board unit (OBU), a real-time kinematic global positioning system, an on-board diagnostics-II (OBD-II) platform, an infrared pavement temperature sensor, and an automated pothole detector, the CAT test vehicles are used for field pilot tests of ITS and CAV technologies developed in the lab. ITSL is also utilized as a testbed for local communities. The sensor fabrication room, for example, develops, tests and deploys cost-effective traffic sensors for low-income communities.

Intelligible Information Visualization Lab

Aritra Dasgupta, Director

In the Intelligible Information Visualization Lab (NiiV), we are a group of data toolsmiths who develop visualization techniques to serve as a transparent lens between what is computed and what is communicated to the human mind. As the playwright George Bernard Shaw observed, “The single biggest problem in communication is the illusion that it has taken place.” This is evident in today’s age, in which information, if communicated properly, can cure diseases and fuel discoveries, but if miscommunicated, can lead to an “infodemic.” To solve this conundrum, the NiiV team pursues intelligibility as the foundational principle for making information more accessible, meaningful and actionable for experts and non-experts alike. We operationalize this principle by visualizing data, big or small, with the ultimate goal of letting human observers see, understand and trust the information that is often generated by black box models. By embracing a human-centered data science approach resulting in interactive visual interfaces, we preserve the best of both worlds: the power of computational methods and that of human reasoning for data-driven decision-making.

Interactive Cross-Reality Lab

Margarita Vinnikov, Director

The Interactive Cross-Reality Lab (iXR) addresses the general areas of interactive mix reality (XR) applications and serious game development. The lab investigates specific topics in virtual and augmented reality and cross-model (visual, audio and haptic) user experiences in the context of driving simulations and military mission planning. Another critical focus in the lab is the design of gaze-contingent displays for gaming and social interaction applications. The lab work is split between simulating and visualizing complex phenomena, such as different weather conditions and complex data formations, and user studies looking at the impact of spatial displacement in the context of navigation and learning.

Media Interface and Network Design Lab

Frank Biocca and Hannah Kum-Biocca, Co-Directors

The Media Interface and Network Design (M.I.N.D.) Lab is a center for the research and design of interactive augmented reality computer interfaces, dynamic data visualizations and human-computer interaction. The M.I.N.D. Lab also conducts human-computer interaction studies assessing the effectiveness of new interactive hardware and software on user performance, learning, cognition and aesthetic experience. Current M.I.N.D. Lab interface design projects include human-scale, near-space magnetic field visualization; interactive AR visualization of artists in museums and displays; AR visualization of biochemical structures: and library visualization and navigation. The museum AR project has won two international awards for augmented reality design. The M.I.N.D. Lab is the local site of a network of three collaborative human-computer interaction labs that over time have spanned the United States, Europe and Asia, including more than 50 computer scientists, neuroscientists, artists and human-computer interaction specialists. Recent M.I.N.D. Lab network projects have been funded by the U.S. Air Force, the National Science Foundation and the European Union, and by clients such as HP, Korea Telecom, Amazon and Samsung.

Robotics and Data Laboratory

Pramod V. Abichandani, Director

The Robotics and Data Laboratory works on problems centered on optimal, multi-dimensional, data-driven decision-making for systems involving multiple aerial, terrestrial, underwater and manipulator robots. Techniques from mathematical programming, linear and nonlinear systems theory, statistics and machine learning are leveraged to create theoretical frameworks and associated real-time embedded systems to solve these problems. Past and current research sponsors include the National Science Foundation, the National Institutes of Health, the Office of Naval Research, Lockheed Martin and Mathworks.

Virtual Technology Applications Lab for Human Simulation

Salam Daher and Frank Biocca, Co-Directors

The Virtual Technology Applications Lab for Human Simulation (ViTALHS, pronounced "Vitals") is a research lab in the College of Computing. The ViTALHS team consists of faculty researchers, software developers, artists, including 3D modelers and animators, Ph.D. students, undergraduate researchers and collaborators with subject matter expertise. Our aim is to design, develop and evaluate human simulations, such as 3D virtual patients, and to develop techniques that improve learning and training for healthcare providers, nursing students and medical students, especially in areas related to human surrogates, including replacements for live humans and digital assistants, as well as for healthcare education. Research areas include human-computer interaction, human surrogates, virtual avatars, augmented reality, virtual reality and mixed-reality experiences that are virtual and physical. Simulations include interactive 3D graphics, multimedia, and multi-sensory immersive elements that span multiple domains, from healthcare, to education, to defense, in order to improve training.

Visual Computing, Graphics and Artificial intelligence Lab

Tomer Weiss, Director

The mission of the Visual Computing, Graphics and Artificial intelligence (VGA) Lab is to solve challenging computational problems in social computing areas, including crowd and collective dynamics and artificial intelligence in computational design. More specifically, we are interested in understanding the dynamics underlying human motion in a space and devising computational approaches for designing better spaces for people. To that end, we utilize tools from a wide range of disciplines, from computer graphics, visualizations and physics-based simulations, to machine learning and computer vision. Current projects include the development of computational algorithms for the automatic synthesis of architectural spaces; computational approaches to select style-compatible furniture for rooms; interactive systems for the design of virtual spaces; and the creation of pedestrian and group dynamics models and their application to robots and swarms.

NJIT RESEARCH DATA AT A GLANCE

R1 Carnegie Classification®
of Institutions
of Higher Education
research ranking

266
patents
and intellectual
property assets
held by NJIT faculty

135
research institutes,
centers and
specialized labs

9
Fellows of the
National Academy
of Inventors

SINCE 2016

77% increase
in external
research
funding

13 winners
of National Science
Foundation CAREER
Awards

$3.2 million
spent on
undergraduate student
research stipends

NJIT
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of Technology

University Heights
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